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Development and initial validation of a dairy biological risk management assessment tool

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Abstract

Disease prevention protocols on dairies, either aimed at keeping disease out (biosecurity), preventing spread of disease on the farm (biocontainment), or reducing the infectious burden have always been a concern. There are a myriad of recommendations available to dairy producers to help minimize disease threats. Dairy operations differ in management style and tolerance of risk, thus there is not a one-size-fits-all answer to minimize disease entry and spread. Risks must first be identified before they can be managed.

Dairy biological risk management (BRM) materials were developed to educate producers and their advisors about identifying disease risk management practices and preventing disease entry and spread to the animals in their care using the concepts of risk analysis: risk perception, risk assessment, risk management and risk communication. The BRM toolbox contains a background document reviewing published disease management protocols for dairy operations, risk management assessment questions to identify various strengths and weaknesses of disease introduction and spread, management protocols for each identified risk, and risk communication tools, all based on disease prevention through five routes of transmission (aerosol, direct contact, fomite, oral and vector-borne). The outcome was a set of peer-reviewed resources available online, free of charge, for dairy producers and their advisors to utilize.

One objective of this study was to report the current biological risk management practices of California and Midwest dairies of different sizes and management styles. This was accomplished by ascertaining producer-reported prevention practices through on-farm interviews utilizing two questionnaires on 80 dairy operations in California and the Midwest. Herd size ranged from 92 to 3,550 head (average 772). There were 64 Holstein herds, seven Jersey herds, one Guernsey herd and eight mixed herds. Production (305 day mature equivalent) ranged from 15,564 to 30,586 pounds (average 24,113) and somatic cell count (SCC) ranged from 110,000 to 954,000 cells/mL (average 284,873).

Reported management practices on a majority of the dairy operations included examining all feedstuffs closely for manure, mold, foreign material, and overall quality (95%), investigating animals that will not eat or do not consume all of their feed (95%), humanely and promptly euthanizing animals that are not going to recover (93.7%), keeping stalls clean

(scraped at least one time daily) (92.3%), inspecting animals daily for signs of illness (90.0%), keeping alley ways clean (scraped or flushed at least one time daily) (87.5%), knowing the origin of all replacement heifers (86.3%), having a fly control program (81.3%), and regularly maintaining the dry lot area to prevent manure buildup and areas of stagnant water (80.0%).

The top three responses for the biggest perceived disease risk/challenge included mastitis – all types (30 herds), FMD (11 herds), and Johne's disease (nine herds). Most farms (70%) introduced animals and the highest SCC were in the herds that introduced lactating and dry cows. Very few of the herds had isolation facilities (22.5%) or utilized quarantine (22.0%) for newly introduced or returning animals. Visitors were reported to exceed 10 per week on 60% of the operations yet only 30% had any type of protocol regarding boots, animal contact, or signing a visitor log. Only 16.3% of dairies utilized their veterinarian's training and skills to necropsy animals that died of undetermined causes.

A majority of dairy operations (71.3%) complied with removing calves at birth prior to nursing. Only 36.3% of herds reported collecting colostrum within 2 hours of calving but nearly 74% of herds fed colostrum by six hours of age. Thirty-five herds (43.7%) in this study pooled colostrum from multiple cows; large herds (>506 head) were more than twice as likely to pool colostrum as compared to smaller (≤505 head) herds.

Scientific data that correlates management practices to production parameters is sparse. The overarching goal of this project was to identify disease prevention practices that correlated with positive outcomes on dairy operations (higher milk production, lower somatic cell count). Introducing animals to a herd did not prove significant when multiple prevention practices were included in the final model, but it remains a critical control point as an independent prevention practice for both milk production and quality.

Prevention practices that correlated with higher milk production and lower somatic cell count included management styles characterized as 'attention to detail'. For instance, fly control, having a SCC less than 200,000 cells/mL, inspecting animals daily, cleaning alleyways, and preventing young animals from contacting manure from older animals were associated with higher than breed average 305 day mature equivalent milk production. The four disease prevention practices that were associated with a lower SCC included removing calves at birth prior to nursing, collecting colostrum within two hours of calving, giving a second dose (1/2 to ¾ gallon) of colostrum 12 hours after the first feeding, and having a fly control program.

Chapter 1. Biological risk management (BRM) on dairy operations by the routes of disease transmission

Dissertation organization

This dissertation consists of six chapters beginning with chapter 1, “Biological risk management (BRM) on dairy operations by the routes of disease transmission” which provides a synopsis of the literature and describes the need for this project. Chapter 2, “Development and formative evaluation of the dairy biological risk management (BRM) online toolbox” describes the background and initial review of the educational materials. Chapter 3, “Development, testing and descriptive results for the biological risk management (BRM) assessment of 80 dairies” reviews the methodology for the dairy study and provides a summary of the questionnaire results. Chapter 4, “Biological risk management (BRM) practices associated with milk production and quality” identifies the specific risk management practices that positively correlate with milk production and quality. Chapter 5, “Lessons learned from the initial validation of the dairy BRM toolbox with recommended modifications” describes the novel approach, limitations and changes to enhance future studies. Tables are included as discussed and citations follow the conclusion section of each chapter. The last chapter contains the general conclusions and overall contribution to science from this project.

Literature Review

Introduction

Each year there are fewer and fewer dairy farms but herd sizes are increasing.(NASS, 2009) From 1970 to 2006, the average herd size in the United States grew from 19 to 120 head.(MacDonald et al., 2007) Certain states have experienced doubling or tripling of their average herd size. This intensity in animal production and farm specialization has allowed dairy producers to efficiently provide food for America and the world. However, these changes in animal production management present opportunities and challenges that were absent three decades ago.

Opportunities for producers include focusing on one segment of dairying: lactating cows, pre-weaned calves, replacement heifer rearing, or feed and forage management. Improved technologies and economies of scale have allowed some dairy producers to specialize in an area that best utilizes their skill set and assets.(Blayney, 2002) This is not unique to the dairy industry; the poultry and swine industries similarly altered their approach to animal production in the last twenty years.(Roberts, 2000) Larger scale animal agriculture production raises concerns for the negative impacts on animal health and economic sustainability due to a catastrophic failure of managing risk from biological causes (diseases).(FAO, 2003) As a result, integrated and capital-intense poultry and swine operations introduced new management concepts to mitigate disease risk and catastrophes. The U.S. dairy industry is not alone in modern production agriculture and its challenges of managing disease risk and can learn from these other industries.

As farms get larger and more specialized, a disease introduction could have devastating effects on animal health and the economic viability of the operation. As an example, bovine tuberculosis (TB) is a contagious and chronically debilitating disease affecting cattle, white-tailed deer and other warm blooded animals including humans. To protect animal and human health, a cooperative State-Federal eradication program administered by U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) was implemented in 1917 and continues today.(USDA, 2008c) While successful in reducing overall prevalence of the disease, TB infected cattle are still introduced onto dairies in the United States. In 2008, seven cows from three California dairy operations were diagnosed with bovine TB.(CDFA, 2008) In order to control this re-emerging disease, over 300,000 cattle were TB tested and more than 8,000 cattle euthanized at a cost of $16 million USD.(CDFA, 2008)

When bovine TB is diagnosed through surveillance programs, epidemiological tracebacks identify the herd(s) of origin and reactor animals are depopulated. Government indemnity payments cover the loss of each animal's life based on fair market value, not to exceed $3,000 per head.(USDA, 2008a) However, owners of registered dairy cattle often sell animals for ten times this amount. Larger, specialized dairy operations have more animals at risk. Financial losses for both types of operations could be overwhelming, even with indemnity.

Disease agents could be introduced in an animal, animal product or through contaminated articles worn or carried by a person.(USDA, 1998) In FY2008, the U.S. Customs and Border Protection intercepted nearly 400,000 animal byproducts, meat or poultry items from individuals who were attempting to illegally bring them into the U.S.(US CBP, 2008) Despite these efforts, there is still a risk for the introduction of a devastating foreign animal disease. Endemic diseases such as Johne's and bovine viral diarrhea (BVD), and re-emerging diseases like bovine tuberculosis, continue to negatively affect animal health and productivity.(USDA, 2008b) The manner in which dairy cattle are raised has changed; so too must the concepts of preventing disease introduction and continuing to ensure animal well-being and a safe food supply.

Biosecurity and biocontainment

Disease prevention protocols on dairies, either aimed at keeping disease out (biosecurity) or preventing spread of disease on the farm (biocontainment) have always been a concern. However, the first dairy specific biosecurity publication, the USDA-APHIS National Animal Health Monitoring System (NAHMS) report, "Biosecurity Measures in Dairy Herds" did not appear until 1993.(USDA, 1993) The 1996, 2002 and 2007 NAHMS Dairy studies each include a specific section about biosecurity; specifically physical contact between animal groups and biosecurity for new arrivals.(USDA, 1996; USDA, 2002; USDA, 2007a)

A wide variety of dairy biosecurity resources have been published in lay journals and on the Internet. Some are focused on disease control for specific diseases (Johne's, mastitis, bovine viral diarrhea, foot warts, and foot and mouth disease).(Rauff et al., 1996; Sischo et al., 1997; Pfizer Animal Health, 2000; BAMN, 2001; Schoonmaker, 2002; Quakenbush, 2003; Collins, 2004; Naugle et al., 2004) Other resources are more general in their recommendations or are focused on specific threats, such as visitors to the farm, expansion herds, or exhibiting animals. (Hill, 2003; DEFRA, 2003; GVMA, 2004; Kirk, 2004; Siebert et al., 2004) Those that addressed the risks from introducing new animals to the herd varied in their recommended times for quarantine or isolation or failed to provide the details for practically implementing the change on dairies. (Wallace, 1996; NYSCHAP, 2001; Kirk, 2003; Wisdairy, 2004)

One national source for dairy biosecurity information, the Dairy Quality Assurance Center, Inc. (DQA) developed a pamphlet, “Biosecurity – Profit for the Taking” in 1998 as an educational instrument for producers and veterinarians.(Dairy Quality Assurance Inc., 1998) The content was also presented in an online training. In 2008, DQA published a peer-reviewed document, “Biosecurity – Foundation for Food Security and Food Safety” which was designed as a ‘risk assessment’.(Milk & Dairy Beef Quality Assurance Center Inc, 2008)

Dairy biosecurity has been the subject of numerous reviews and continues to be discussed at veterinary and producer meetings, in dairy industry publications, as well as through cooperative extension service and state departments of agriculture. (Thomson, 1997; Garry, 1998; Godkin et al., 1999; NYSCHAP, 2001; Dargatz et al., 2002; Kirk, 2003; Mass Dept Food Ag, 2003; PSU, 2004; Bickett-Weddle, 2004; Bickett-Weddle, 2005a; Lombard et al., 2008) Topics ranged from general recommendations to specific disease management topics.

A report published by Moore, et al. in 2008 described an extensive list of biosecurity recommendations for dairy and other agricultural animal species that were available on the World Wide Web.(Moore et al., 2008) There was no shortage of information regarding dairy biosecurity recommendations, but overall there was a lack of consistency, depth of information and evidence for the cost-benefit of many of the recommendations. (Moore et al., 2008; Lombard et al., 2008) A detailed, comprehensive list of instructions for implementing various biosecurity recommendations for all life stages on dairy operations did not exist, although many sources reported that risk assessment, or assessing the farm was an important biosecurity management practice. Despite the fact that many different recommendations exist, the reality is that each dairy operation is different and there is not a one-size-fits-all answer. Risks must first be identified before they can be managed.

Biological risk management

The term biosecurity is widely used but its application varies among countries and can present translation problems in certain languages. The Food and Agriculture Organization of the United Nations (FAO) Expert Consultation discussed its use in communication documents. This group defined biosecurity in the broadest of terms as the concept, process and objective of managing biological risks associated with food and agriculture.(FAO, 2002b) It was concluded that as long as it is italicized and capitalized, the term *Biosecurity* could be retained.(FAO, 2002b) This same group generated the document, “Biological Risk Management in Food and Agriculture: Scope and Relevance” that provided some guiding principles that can be applied internationally to protect animal and public health and at the farm level. One notable item was the recognition of using hazard identification and principles of risk analysis as part of a “whole-cycle” approach to managing disease at farm or country-level. The authors reported that a holistic approach has benefits and that a “toolbox” with proven practices in regards to risk management at the local, national and international levels is needed for synergism.(FAO, 2002a)

In response to the need for a holistic approach, consistent recommendations, and the ability to customize disease risk management for a variety of livestock operations, a set of tools was developed by a group of veterinarians at the Center for Food Security and Public Health (CFSPH) at Iowa State University. The phrase ‘biological risk management’ from the FAO document was used to describe this project as opposed to the term biosecurity. Biological risk management (BRM) and the concepts it entailed encapsulated the approach of educating livestock producers and veterinarians about identifying disease risk and preventing disease entry and spread to the animals in their care. Biological risk management (BRM) also fit with the Center’s mission of ‘increasing national and international preparedness for accidental or intentional introduction of disease agents that threaten food production or public health”. (Roth, 2002)

Scope of the biological risk management (BRM) toolbox

Biological risk management (BRM) accounted for the fact that disease risk cannot be completely eliminated, but it can be managed through effective control measures. The concepts of the epidemiology triad, host – agent – environment, were applied.(Pfeiffer, 2002; LeBlanc et al., 2006) These concepts were essential in the selection of the first audiences for BRM. The swine and poultry industries tended to focus their efforts on disease exclusion. For the most part, modern swine and poultry production facilities have systems in place to accomplish that task. This was not the case for the majority of cattle operations; they are fundamentally different in husbandry, production cycles, and nutritional needs.

Complete exclusion of all diseases was not deemed a practical approach for the majority of cattle operations. Developing a method to assess an operation for what disease prevention practices are in place to prevent disease introduction or spread, and identifying vulnerabilities so producers could make informed decisions on managing disease was the overarching goal of BRM. The information presented in the dairy BRM toolbox focused on ways to minimize the infectious burden on farm and enhance an animal's innate ability to withstand disease challenges to maintain health, production and overall economic viability of the dairy.

Biological risk management (BRM) tools were developed by CFSPH in 2004 for veterinarians to use with beef, dairy, and equine operations. The CFSPH BRM program used the concepts of risk analysis: risk perception, risk assessment, risk management and risk communication.(BAMN, 2001; FAO, 2002c) A portion of the tools were modified in 2006 for direct use by dairy and beef producers. The first author of this manuscript was the dairy subject matter expert. Partial funding for the development of these educational materials was provided by the Centers for Disease Control and Prevention, the U.S. Department of Agriculture Risk Management Agency, and Iowa State University.

The first BRM tool developed was a background document reviewing published disease management protocols for dairy operations. It included details about each production life stage, where disease risks are encountered and specific steps to manage them. A literature search revealed biosecurity topics dating back to 1987 for the poultry industry and 1992 for swine.(Gifford et al., 1987; Moore, 1992) Since basic disease control principles are not species specific, applicable recommendations from these industries were incorporated into the dairy BRM materials.

Risk management assessment tools were also developed. Open-ended assessment questions gathered information about milk production and quality parameters, herd demographics, on-farm protocols for visitors, new animal introductions, and vaccinations. Closed-ended questions identified various strengths and weaknesses of disease introduction and spread on a dairy operation. Reports and educational handouts were also developed to educate dairy producers about disease risk and specific details to manage it.

Risk perception

The first phase of risk analysis is to identify an individual's perception of risk. Risk perception is often influenced by previous experience, the media, and locale.(Slovic, 1987) A dairy producer's perceived risk, right or wrong by another's standards, ultimately affects how, or if, change is carried out. By identifying what is viewed as a threat to an operation, management protocols can be tailored to address these concerns.

Risk means different things to different people and acceptable risks also vary between individuals. For example, two dairy producers may perceive Johne's disease as a risk to their cattle. One producer may put numerous control mechanisms in place to prevent disease entry or spread. Another producer accepts the risk and instead of preventing it, tolerates production losses. The producers may have the same perception of risk but different tolerance.

Scientific advancements such as vaccines and antibiotics have also influenced the perception of infectious diseases and how they are managed.(Garry, 1998) With these tools, some dairy producers may choose to vaccinate or treat their way out of disease situations rather than prevent their entry. The choice to vaccinate, extrapolated from what is known in human medicine, often depends on the likelihood of disease occurring, susceptibility to the disease of concern, and severity if disease were to occur.(Brewer et al., 2007) Producers may make herd vaccination decisions based on the same three concepts.

Aside from risk perception and tolerance, some individuals may have negative perceptions associated with risk management. These are often based around ideas of disbelief, "that practice will not work to stop disease entry" or economic concerns, "vaccination is too expensive".(Rauff et al., 1996; Vaillancourt and Carver, 1998) While it is difficult to prove and measure the benefit of things that do not happen, counter-arguments tend to fall into three categories: there is a risk, it is economically worthwhile to prepare, and the overall impact must be considered. Vaccines are not 100% effective, carrier animals can perpetuate disease in a herd, and increasing concern with antibiotic resistance are all realities of dairy production in the 21st century.(Kelly, 2005) Awareness and understanding of disease management practices are crucial for their ultimate implementation.(FAO, 2002a)

On-farm risk management assessments

The dairy cattle industry in the United States is faced with enormous responsibilities; maximizing animal health, optimizing milk production and quality, producing an economically viable food source for the world, and continuing to improve the genetics of tomorrow's dairy cow. Given the variation in dairy operations to accomplish these tasks, managing disease risk must be customized. Risks should be identified with a hazard assessment to define the critical control points of disease entry and spread on each operation, an approach the food processing industry has utilized for years.(Cullor, 1997; Dargatz et al., 2002; Villarroel et al., 2007; Maunsell and Donovan, 2008)

Risk assessments can be used to guide implementation of specific disease control practices.(Hoe and Ruegg, 2006) This principle has been applied to a few cattle diseases such as bovine viral diarrhea (BVD) and Johne's disease (caused by *Mycobacterium avium* subspecies *paratuberculosis*). The etiology of these diseases has been extensively studied and assessments have been designed based on critical control points for disease introduction and spread. However, risk assessments do not exist for all diseases affecting dairy cattle, such as infectious bovine rhinotracheitis (IBR), *Mycoplasma*, *Salmonella,* cryptosporidiosis and others.

Several universities and state agriculture departments have utilized some form of a risk assessment to assist their producers in managing BVD, purely on a voluntary basis.(WSU, 2007; NYSCHAP, 2008; MS BOAH, 2008; Montana BQA, 2009) Although there is not a uniform BVD risk assessment tool available, overlap occurs in key disease management principles. Researchers in Northern Italy used a BVD risk assessment tool combined with serology as a predictor of herd status.(Luzzago et al., 2008) This demonstrated the value of incorporating a risk assessment as part of an overall herd approach to BVD control by strategic use of diagnostics to limit expense.

USDA-APHIS developed the Uniform Program Standards for the Voluntary Bovine Johne's Disease Control Program in 2002. This multifaceted approach utilizes certified accredited veterinarians to conduct on farm risk assessments to identify management strategies that may predispose to spread of the Johne's disease agent.(USDA, 2006) Developing a standard risk assessment for this program was the goal of a task force of the U.S. Animal Health Association, National Johne's Working Group in 2003.(USAHA, 2003) This quantitative assessment examines a variety of on farm critical control points and assigns a risk score (low, moderate, high). For a single disease entity with identifiable transmission risks, this approach is suitable.

The National Research Council (NRC) recommended that a joint industry-government Johne's disease control program broadly focus on preventing the spread of all fecal-oral pathogens in their 2003 report. Specifically, recommendation four was aimed at developing educational resources that control risk factors instead of focusing on control of a single etiologic agent.(NRC, 2003)

Routes of disease transmission

The approach taken in the development of the CFSPH biological risk management tools was to look at diseases, not based on the agent or clinical signs produced, but rather on the route of transmission to the animal or human (in the case of zoonotic diseases). An advantage of this approach is that it will also help protect against new or unanticipated infectious agents. While disease agents and the infections they produce vary depending on if they are a bacterium, virus, parasite or prion, they all have one thing in common: the animal must be exposed to them to develop disease. It is important that animal caretakers understand that certain pathogens can be acquired orally and others are acquired by aerosol transmission. Those are visual things that people can grasp and better yet, gain control over. From a disease management standpoint, hazards must first be identified and then protocols designed to minimize exposure.

This disease control approach was used as far back as 1892 when contagious bovine pleuropneumonia was eradicated from the United States. At the time, the etiologic agent *Mycoplasma mycoides* subspecies *mycoides* was not yet identified but control methods were put in place based on what was known about the epidemiology of the disease.(Schwabe, 1984) Designing prevention protocols with specific applications, such as minimizing fecal contamination of feedstuffs by using separate loader buckets for feed and manure handling, provides action steps that producers can implement to control disease spread. Producers do not necessarily need details about a disease agent’s etiology, only the critical control point. Based on the recommendations of the NRC in 2003, this approach will provide a broader prevention strategy. (NRC, 2003)

Pathogenic agents can be spread from animal-to-animal or animal-to-human and vice versa, through a variety of transmission routes. For the purposes of the CFSPH biological risk management resources, the following categories and corresponding definitions guided development of assessment questions and management recommendations. A variety of sources were consulted and etiologies for specific diseases reviewed to generate each of the definitions in Table 1.(Drost, 1996; Aiello, 1998; Osterholm et al., 2000)

Table 1. Routes of disease transmission and corresponding definitions for BRM

Route	Definition
Aerosol	Pathogenic agents contained in aerosol droplets are passed from one animal to another, or between animals and humans. Most pathogenic agents do not survive for extended periods of time within the aerosol droplets and close proximity of infected and susceptible animals is required for transmission.
Direct contact	A susceptible animal becomes exposed through physical contact when the agent from an infected animal or the environment enters open wounds, mucous membranes, or the skin through blood, saliva, nose-to-nose, rubbing, or biting another animal. Some disease agents can spread between animals of different species, as well as to humans. Subtype: *Reproductive* – Diseases spread through venereal contact (from animal-to-animal through coitus) and in-utero (from dam to offspring during gestation).
Oral	Consumption of pathogenic agents in contaminated feed, water or licking/chewing on contaminated environmental objects. Feed and water contaminated with feces or urine are frequently the cause of oral transmission of disease agents. Contaminated environmental objects could include equipment, feed bunks, water troughs, fencing, salt and mineral blocks, and other items an animal may lick or chew.
Fomite	A contaminated inanimate object transmits a disease agent from one susceptible animal to another. Involves a secondary route of transmission (direct contact or oral) for the pathogen to enter the host. Examples include contaminated shovels, clothing, bowls/buckets, brushes, tack, and clippers. Subtype: *Traffic* – Vehicle, trailer, or human causes the spread of a pathogenic agent through contaminated tires, wheel wells, undercarriage, clothing, or shoes/boots by spreading organic material to another location.
Vector-borne	An insect acquires a pathogen from one animal and transmits it to another either mechanically or biologically. Mechanical transmission: disease agent does not replicate or develop in/on the vector; it is simply transported by the vector from one animal to another (e.g., flies). Biological transmission: vector takes up the agent, usually through a blood meal from an infected animal, replicates and/or develops it, and then regurgitates the pathogen onto or injects it into a susceptible animal. Fleas, ticks, and mosquitoes are common biological vectors of disease.
Zoonotic	Diseases transmitted between animals and humans. Human exposure occurs through one of the previously listed five main routes of transmission (aerosol, direct contact, fomite, oral, and vector-borne).[a] It is a separate route of transmission due to its importance.

[a] Reference (Acha and Szyfres, 2001)

Environmental contamination must not be overlooked as part of a disease management control program. Dairy cattle are often exposed to pathogens in the environment where they are housed and milked. Many disease agents can survive for extended periods of time in soil, bedding, or other organic material. However, animals or humans acquire environmental pathogens through one of the previously defined categories: inhalation (aerosol), oral consumption, direct contact, or via fomites.

Domestic and foreign animal diseases

Management protocols based on the route of transmission approach can reduce the infectious burden for diseases already present in the herd. For instance, if the adult cattle are carriers of an endemic disease agent, management protocols can be put in place to limit their contact with young stock. Preventing direct contact, shared air space or equipment between these groups are all management techniques that can be implemented to decrease exposure. Decreased herd prevalence or environmental contamination has the potential to reduce the economic impact of existing diseases.

The route of transmission approach has the added benefit of guarding against exotic and less common diseases. To illustrate this concept, a review of the routes of transmission for a foreign animal disease, FMD, and a domestic disease, BVD, is warranted. Cattle can become infected by the aphthovirus that causes FMD through inhalation (aerosol), direct contact, fomites, and orally.(CFSPH, 2007) The pestivirus that causes BVD is spread to cattle via aerosol droplets, direct contact, fomites, orally and vectors.(Kahn and Line, 2008) Neither disease is zoonotic. Implementing critical control points based on the routes of transmission approach for BVD could aid in preventing FMD from entering a dairy should it ever be introduced to the U.S.

Risk management practices

Disease management practices should focus on minimizing identified risks. One approach to disease prevention is to focus on the critical control points for a dairy operation.(Villarroel et al., 2007; Noordhuizen, 2008; Boersema et al., 2008) Numerous authors have described five management areas that have the potential to introduce or spread disease: introduction of animals, people, nutrients (feed, water), equipment, wildlife/rodents/vectors.(BAMN, 2001; van Schaik et al., 2002; England, 2002; Kirk, 2003; PSU, 2004; Villarroel et al., 2007; Maunsell and Donovan, 2008; Milk & Dairy Beef Quality Assurance Center Inc, 2008)

Since dairy operations differ in each of these key management areas, customized risk assessments and plans are essential. The National Research Council stated, "risk assessment is defined as a general process for linking science to decision-making".(National Research Council, 1993) To be effective, programs designed to minimize disease entry or spread should be decision-focused and flexible to meet the needs of individual dairy operations.(Wells, 2000) Risk management guidelines should be developed with the input and support of those affected. Determining which biological risk management practices to implement on a dairy operation should also involve as much science as possible. However, data is lacking on which practices work or positively affect a dairy's milk production and quality parameters.

Need for validation of biological risk management practices

There is an abundance of dairy biosecurity recommendations available but scientific data that correlates management practices to production parameters is sparse. Most publications focus on housing, feed, calves, milking and genetics as it impacts milk production.(Jones et al., 1984; Keown, 1988a; Jordan and Fourdraine, 1993; Losinger and Heinrichs, 1996; Oleggini et al., 2001a; Kellogg et al., 2001a; Smith et al., 2002a) Peer-reviewed publications also focus on management practices for specific disease entities or segments of the dairy industry (heifer management, udder health).(Heinrichs et al., 1987; Wray, 1989; Goodger et al., 1993; Spicer et al., 1994; Rauff et al., 1996; Wilson et al., 1997; Vaessen, 1998; van Schaik et al., 2002; Lievaart et al., 2007; Wenz et al., 2007; Maunsell and Donovan, 2008)

In a study by Cassel, et al, dairy producer's lack of awareness of management practices was a bigger problem than a lack of resources, technology or equipment.(Cassel et al., 1994) As an attempt to address this issue, the dairy BRM assessment questionnaire was written such that the desired answer is always yes. Assessing the risk management practices in this manner allows for increased awareness about the practices that prevent or control disease. The assessment process becomes an on-farm 'teachable moment'.

Despite identifying critical control points, dairies do not always carry out the recommended changes. Implementation studies on dairies have identified gaps between awareness of prevention practices and accomplishment.(Rauff et al., 1996; Faust et al., 2001; Hoe and Ruegg, 2006; USDA, 2007a) Dairy producers are not unique in their selective adoption of disease prevention practices. Swine producers in Spain implemented biosecurity measures based on what they perceived as important to disease prevention, regardless of the actual risk.(Casal et al., 2007) The actions of farm managers on poultry operations in Ontario did not comply with what they reported on a self-assessment of biosecurity practices.(Nespeca et al., 1997) In general, Australian producers of meat-type poultry increased their adoption of biosecurity practices between 2000 and 2005 but a lower adoption rate was observed in independently owned farms.(Ij, 2007)

Public health relies on the concepts of ‘social marketing’; using commercial marketing technologies to influence voluntary behavior to personally improve. This entails showing the accessibility, promoting interventions, benefits, and associated cost using consistent messages to influence behavior.(Coreil et al., 2001) The dairy BRM assessment tool is accessible, the health and well-being of cattle is promoted in the educational tools, and the assessment reports identify the benefits to disease control; the missing component is cost. A dairy’s economic bottom line is tied to income from the sale of milk which is based on production parameters and quality. There is a need to demonstrate a correlation between biological risk management practices and milk production or quality parameters. Producers could use this information to decide if there is financial incentive for their dairy to implement change and overcome this barrier.

Conclusions

Dairy producers’ perception and acceptance of risk differs and should be considered when developing BRM practices. Assessing risk based on routes of transmission provides a more complete and holistic approach and avoids over or under emphasizing specific disease(s). This focus will make the information applicable to dairy producers and their advisors regardless of their educational background. It will also remain relevant as scientific advances improve the understanding of disease introduction or spread. However, while disease risk cannot be completely eliminated, it can be managed. Tailoring the BRM program for each producer based upon his/her risk perception, risk tolerance, and resources are essential.

A successful BRM program relies on effective communication to ensure a consistent message is presented to everyone involved in the implementation of the disease prevention practices. A program must be understood and supported by everyone in order to be effectively implemented. The success of the risk management plan lies in how it can be carried out, who is responsible for making changes happen, and how to incorporate the practices into daily activities.

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Chapter 2. Development and formative evaluation of the dairy biological risk management (BRM) online toolbox

Introduction

The dairy industry is changing, with fewer farms each year but more animals per operation. The manner in which dairy cattle are raised is evolving. So too must the concepts of preventing disease introduction while continuing to ensure animal well being and a safe food supply. Dairy biosecurity recommendations are abundantly available to help producers accomplish this task. However, the recommendations are inconsistent or lack sufficient details to practically implement the change.(Moore et al., 2008; Lombard et al., 2008) Many different solutions to preventing disease exist and because all dairy operations are different, there is not a one-size-fits-all answer. The over-arching recommendation to producers is that risks must first be identified before they can be managed.

In response to the need for disease risk assessment, a group of veterinarians at the Center for Food Security and Public Health (CFSPH) at Iowa State University developed biological risk management (BRM) tools. The first author of this manuscript was the dairy subject matter expert. The dairy BRM tools educate producers and their advisors about identifying disease risk management practices and preventing disease entry and spread to the animals in their care using the concepts of risk analysis: risk perception, risk assessment, risk management and risk communication.(BAMN, 2001; FAO, 2002c) The BRM toolbox contains a background document reviewing published disease management protocols for dairy operations, risk management assessment questions to identify various strengths and weaknesses of disease introduction and spread, management protocols for each identified risk, and risk communication tools, all based on disease prevention through five routes of transmission (aerosol, direct contact, fomite, oral and vector-borne). The objective of this chapter is to describe the development and testing of the dairy BRM toolbox.

Risk assessments

Risk assessments evaluate the probability that a disease agent could enter, become established or spread within a herd and considers the magnitude or impact of loss.(OIE, 2008) As much as possible, risk assessments should be conducted using verifiable, scientific data to reduce uncertainty in disease probability estimates or overall impact. Risk assessments have been used to identify risks in food processing to protect public health as well as importing animal diseases into a country to protect both animal and human health.(CAC, 1999; OIE, 2008) Recently, risk assessments have been applied to animal welfare to evaluate management and outcomes for improvement on a livestock operation.(Bracke M.B. et al., 2008)

One way to identify hazards of disease introduction and characterize risk on a dairy operation is to utilize a series of investigative questions to obtain qualitative and quantitative information on management, herd performance and disease threats. In animal production settings, measurable data on all aspects of disease exposure is often deficient. However, risk assessments are still useful tools because they can identify gaps in knowledge to drive future research to reduce uncertainty surrounding disease exposure.(NRC, 1994)

When quantitative data is lacking, utilizing expert opinion to qualify risks is an alternative option.(EFSA, 2006) The process, referred to as the Delphi method, was used in the development of the porcine reproductive and respiratory syndrome (PRRS) risk assessment tool.(Derald Holtkamp and Dale Polson, personal communication) For a specific disease or focused issue, this is a viable option. Risk assessments provide great value in identifying risk sources and quantifying the risk for decision making and policy development.

The benefits of performing a true risk assessment were considered in the development of the BRM program. Given the lack of science available for the wide variety of biosecurity recommendations to ‘quantify’ risks, and lack of self-identified subject matter experts on the various dairy biosecurity protocols to ‘qualify’ risks, another approach was warranted. To assess the number and type of BRM prevention practices implemented on a dairy operation to reduce the probability of disease entry or spread, a risk ‘management’ assessment was created.

The overarching goal of this project was to identify disease prevention practices that correlated with positive outcomes on dairy operations (higher milk production, lower somatic cell count). This was accomplished by ascertaining producer-reported prevention practices from a variety of dairy operations in the United States. Quantitative values for milk production and quality parameters were collected as the response variables. More information about the data collected and final results are available in Chapters 3 and 4 of this dissertation.

Methods

Dairy BRM background document

The first phase in the development of the dairy BRM toolbox was to research and write a background document. The initial goal was to include science-based recommendations that described effective disease prevention protocols for dairy cattle. There was not an extensive list, so commonly recommended practices were also included. Biosecurity recommendations from cooperative extension, industry groups for dairy and other species (swine, poultry), state and federal government reports, peer-reviewed and industry publications were all evaluated for applicability and included in the document where appropriate.(Bickett-Weddle and Ramirez, 2004) Animal facilities and production cycles for dairies differ from swine and poultry, so applicability was based on feasibility to implement a specific practice and its relevance to a dairy operation. The need to validate, through demonstration of the benefits of some of these common recommendations, was the driving force behind this project.

Risk management assessment

The risk management assessment consisted of two questionnaires. The pre-assessment questionnaire (PAQ) was designed to gather herd demographic details through a series of open-ended questions. The assessment questionnaire (AQ) was designed to identify strengths and weaknesses in disease management practices on the farm and to increase dairy producer awareness of published or industry biosecurity recommendations using closed-ended questions.

Pre-assessment questions

The original PAQ consisted of 19 open-ended questions with five topics: animals, facilities, people, risk perception and vaccination protocols.(Bickett-Weddle, 2005b) Demographics specific to the operation included the number of cattle and housing types for lactating, dry, and pre-fresh cows, pre-weaned, weaned, pre-breeding, and bred heifers, breed(s), and milking frequency. The number of employees, language(s) spoken on farm, number of visitors and required on-farm protocols were also included. Questions were included about the producer's disease concerns and challenges to help guide the assessment and management-recommendation process.

A table was included in the PAQ that listed the organisms commonly found in commercial vaccines (no product names were used). Data included how the product was administered (oral, intranasal, intramuscular, subcutaneous) and product type (killed or modified live) for each of the age groups that were raised on the farm (pre-weaned, weaned, pre-bred, dry cow, pre-fresh, lactating).

Assessment questions

Based on the content from the dairy BRM background document, published questions from Johne's disease and bovine viral diarrhea (BVD) risk assessments and dairy quality assurance programs (DQA), specific risk management assessment questions were written for lactating cows, maternity/calf, replacements, sick/treatment and general dairy. These segments corresponded to the dairy BRM background document and key areas on the farm where disease introduction or spread can occur.

This assessment tool consisted of a series of closed-ended assessment questions stating published or industry recommended practices that should reduce the risk of disease entry or spread. Each assessment question was worded such that if the producer was performing the prevention practice he/she answered 'yes'. Estimating probability of disease and the consequences were not included in the initial BRM assessment due to the complex modeling required to perform the task. The need to maximize education time on farm during the assessment process took precedence with the CFSPH veterinary development team rather than analyzing complex data. The advantages and limitations of this approach are discussed in more detail later in this chapter.

In all, 210 closed-ended questions with response choices of 'yes', 'no' and 'maybe' were developed. Each assessment question was assigned a code, DQXXX. For instance, DQ4 could appear in multiple segments depending on applicability to that life stage.

Each assessment question was evaluated by two or more CFSPH veterinarians to determine which of the various route of disease transmission categories (aerosol, direct contact, fomite, oral, vector or zoonotic) would be impacted by that particular practice. Each question was then assigned to one or multiple transmission-route categories and coded ‘behind the scenes’ such that the assessor was not aware of which questions pertained to which route(s). The original format of questionnaires, route categories and reports were generated using Microsoft® Excel™. The final recommendation report was manually prepared, typing the identified vulnerability and possible solution into a Microsoft Word® document.

Management recommendations

One or more statements called “management recommendations” were written for each assessment question. Scientific data were included wherever possible. For the common recommendations that were lacking scientific evidence, an explanation of why the practice should be implemented was included. The recommendation often incorporated statements addressing the route(s) of disease transmissions identified for that question. Each management recommendation was also assigned a code, DMXXX that corresponded to an assessment question. In all, 226 unique management recommendations were developed. Assessment questions had unique or repeated recommendations depending on how much explanation was needed. In some cases, the same recommendation was used for multiple assessment questions.

Peer review

In July 2004, the dairy document, assessment questions, and management recommendations were sent to three veterinarians with experience in different aspects of the dairy industry. Representing large dairy herds and industry was Dr. Mark Kirkpatrick from Idaho who had spent several years in dairy practice in the Midwest followed by graduate school. His review focused on applicability of the content to large dairy herds. Representing small to medium-sized Midwest herds and private dairy practice was Dr. Loren Wille from Wisconsin who was born and raised on a dairy farm in the Midwest. Dr. Wille’s review focused on the practical, daily implementation of the BRM recommendations. Representing medium to large-sized Eastern herds and private dairy consulting practice was Dr. Dave Horn from New York. Having practiced dairy production medicine for several years and providing financial management and herd health consulting to dairies, Dr. Horn focused on the dairy financial consideration of the concepts introduced.

A CD-ROM containing the dairy document, assessment questions and management recommendations in the Excel® format was provided to the American Association of Bovine Practitioners (AABP) Food Quality, Safety and Security committee as well as the AABP Board of Directors in September, 2004. Members were asked to review the content and provide feedback. Step-by-step instructions were provided for using the assessment spreadsheet and reviewers were notified that an online database was being developed.

Pilot testing

In August 2004, a set of 98 assessment questions was tested by the dissertation author in an in-person interview format. Interviewees consisted of two clinical food animal veterinarians, and one veterinarian and one staff person in charge of daily feeding and cleaning for the large animal section of the Iowa State University Veterinary Teaching Hospital. Notes were taken during the assessment process regarding the wording and phrasing of questions. Awkward, overly wordy, or questions requiring additional explanation were edited and clarified for future use.

The Iowa State University Dairy Farm Manager tested the dairy pre-assessment questionnaire (PAQ) in August 2005. He received the questionnaire in the mail and was asked to answer each of the questions to the best of his ability prior to the scheduled on-farm visit. Questions left blank were discussed during the on-farm visit with the person(s) tasked with completing it. Confusing questions were identified and clarifications made.

The AQ was also tested by third-party interviewers with the Iowa State University Dairy Farm Manager. The AQ consisted of 176 questions selected by the dissertation author. The interviewers were fourth year veterinary students taking the Introduction to Dairy Production Medicine course at Iowa State University, College of Veterinary Medicine. Students were instructed to read each question as written and allow the dairy producer to provide an answer, unaided. The dairy producer was informed of the possible responses, ‘yes’, ‘no’ and ‘maybe’, prior to asking the first question. The dissertation author supervised the assessment interviews and took notes on questions that appeared confusing or required further explanation. The students were debriefed after the interview to gather suggestions for improving the questionnaire.

Results

Dairy BRM background document

The 37 page dairy BRM background document described the scope of the dairy industry and the importance of disease risk management.(Bickett-Weddle and Ramirez, 2005) (Appendix 1) A 28-page condensed version was also generated, “Dairy BRM – Key Points” that described the same information but in a bulleted format for quick reference. The topics of risk perception, risk management and risk communication were addressed. A section was also devoted to human traffic (employees and visitors) on the dairy and preventing zoonotic diseases.

The risk management section of the document provided a review of the life stages of a dairy animal and described the variability in management styles. Disease management practices were outlined for various housing types, milking procedures, dry cows, pre-fresh cows, calving, replacement heifers and handling newly introduced animals. Biological risk management protocols focused on the routes of disease transmission (aerosol, direct contact, fomite, oral, and vector-borne).

Peer-review

Reviewer comments were integrated into the dairy BRM background document where applicable and additional details added to address the scope of different dairy operations. Assessment question and management recommendation wording were also improved and wording was clarified based on reviewer comments.

AABP Food Quality, Safety and Security committee members and several AABP board members commented that the resources were valuable for practitioners and felt they should be promoted to AABP members. Developing a pre-conference seminar at future annual meetings for members was discussed. No additional suggestions for improvement of the risk assessment tool were received.

The original format of questionnaires, route categories and reports in Microsoft® Excel™ was evaluated for usability by reviewers and the development team. While the software was readily available, inexpensive and allowed for the selection of specific assessment questions and printing, the program had limited report-generation capabilities. Final report generation required a considerable time investment by the assessor and was identified as a limitation to user acceptance. Broad distribution of a spreadsheet assessment tool would not allow for question and management recommendations to be easily updated or for the rapid generation of customized reports with user comments. Other options of distribution were explored.

Online database

Funding was available to allow transformation of the spreadsheet of assessment questions, route categories and management recommendations into an online database. Working with instructional technologists and programmers at Iowa State University, assessment questions and reports were made available in an online format. This development process took nine months from initiation through beta-testing and release in March, 2005. The result was a dynamic interface allowing administrative updates to questions, customizable management recommendation reports by adding assessor comments, assessor selection of recommendations to include in the final report, additional reporting formats, and direct links to educational content. The online database is a free resource but registration is required. It is available at: www.cfsph.iastate.edu/brm.

BRM database reports

A series of three types of reports were created to describe the strengths and weaknesses of the dairy operation. Each report was generated based on the responses to the assessment questions entered into the online database. Questions answered ‘no’ or ‘maybe’ generated a management recommendation report. Questions answered ‘yes’ generated the prevention practices report. All responses contributed to the route of transmission charts. Questions skipped during the assessment process were not included in the final output.

Management recommendations

Two different ‘Management Recommendation’ reports could be generated based the ‘no’ or ‘maybe’ responses to the assessment questions. This report reiterated the disease prevention practices that were not, or not always, implemented on the dairy. Each pre-assigned management recommendation code, DMXXX, was printed on all corresponding reports for communication purposes between assessors and administrators. (Appendix 2)

The online database could include comments about the assessment questions from the assessor. Once entered into the online database, those comments could be added to the operation's management recommendation report. The assessor could print out all questions with no/maybe responses with the corresponding pre-written management recommendations and comments, or select specific question/recommendation/comment combinations.

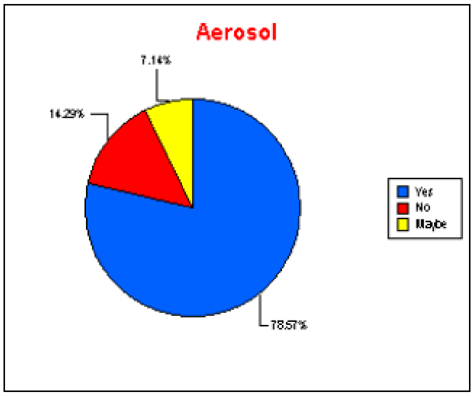
Prevention practices

All 'yes' responses from an assessment question generated a 'Current Prevention Practices' report. This report transformed each question into a positive statement. For instance, 'cows are kept away from fence to fence contact with other livestock' and 'your somatic cell count is routinely under 200,000'. The assessor had the option of printing all prevention practices or selecting specific ones for the final report. Each assessment question in the database had a corresponding current prevention practice, also coded (DPXXX) in the same manner as the assessment questions and management recommendations. In all, 210 statements were developed for the online reports. (Appendix 3)

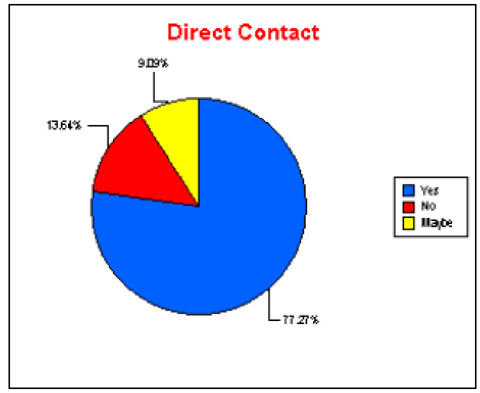
Route of transmission charts

The number and percent 'yes', 'no', and 'maybe' responses were represented in a pie chart for each of the routes of disease transmission: aerosol, direct contact, fomite, oral, vector and zoonotic. Each pie chart included the statement, 'total responses that applied to XXX route'. (Figure 1) Not all disease transmission routes had the same number of responses so direct comparison between pie charts is not applicable (i.e., the denominators are not the same). Assessors had the flexibility to choose assessment questions and the route graph report may reveal a focus on practices involving fomites or direct contact and not vectors or zoonotic disease risks.

Figure 1. Example pie charts from the Route Graph report demonstrating the percent yes, no and maybe responses for the corresponding route of transmission. The percents are calculated for each route based on the responses to each question that codes for that route.



Total Responses that applied to Aerosol Route = 14



Total Responses that applied to Direct Contact Route = 22

There were two different formats for 'Route Graph' reports, and each could be printed in color or black and white. The one page version included all pie charts on the same page and blank lines on the bottom of the page to hand write additional comments. The two-page version printed three pie charts on each page with blank lines next to each route for entering hand written comments. (Appendix 4)

Responses

The 'All Responses' report could also be generated as a written record of the responses for each question answered during the assessment process. The assessor's comments were included but no additional information (recommendations, routes). (Appendix 5)

Risk communication tools

Handouts and Microsoft® PowerPoint® presentations were written for a cattle producer audience and included specific details about how to manage diseases spread by aerosol, direct contact and reproductive spread, oral, fomite, vector-borne and zoonotic transmission. This information, in English and Spanish, was designed to be used by extension personnel to help cattle producers identify and manage disease risk.

Development and dissemination of this information to cooperative extension personnel in the U.S. was made possible by funding from the U.S. Department of Agriculture's Risk Management Agency and Iowa State University in 2005. These communication tools also supplemented the online assessments and route graph reports and are available for download free of charge at: http://www.cfsph.iastate.edu/BRMForProducers/default.htm.

Discussion

Rather than focusing on specific disease agents that cause mastitis, respiratory disease, or calf scours, dairy biological risk management tools focused on the routes of disease transmission (aerosol, direct contact, fomite, oral, and vector-borne). This approach was in accordance with the National Research Council's 2003 recommendation of controlling risk factors rather than on specific disease agents and FAO's "whole cycle" approach of managing disease.(FAO, 2002a; NRC, 2003)

Pre-assessment questions

No two dairy farms are identical and the pre-assessment questionnaire (PAQ) was designed to identify the uniqueness of each operation. It discovered how many animals were raised on farm, number of employees and visitors, and whether animals were introduced as an overview of some of the aspects related to potential sources of disease introduction on a dairy operation. The information obtained in the pre-assessment questionnaire was not entered into the online database but guided the assessor on question selection for the on-farm assessment.

Dairy operations rely on a human workforce to care for the animals and this group was a critical part of the assessment and education process. For change to occur, effective communication is necessary. This began by gathering details about the target audience in the PAQ so educational materials could be provided in a format that will be understood by those implementing the disease prevention practices.

Since risk perception and tolerance varies between individuals, the PAQ included the questions, 'what diseases are you most worried about occurring at your facility' and 'what do you perceive as the biggest biosecurity risk/challenge(s) for your facility'. This information should guide the management recommendation process by including recommendations for the diseases or challenges of concern. Judging the legitimacy of a dairy producer's concerns was not the goal; rather it was to understand dairy producer's perception of disease risk and address the challenges in the final report.

For certain diseases, vaccination programs are one way to manage introduction and spread on dairy operations.(Rauff et al., 1996) To better understand how dairy producers utilized this management tool, a vaccination protocol table was included in the original PAQ. Specific product names were not included, only a list of organisms. This was to ensure future applicability because products vary in their organism combination and companies merge over time. The goal of this tool was to increase awareness of vaccination protocols and verify the actual products handled on farm and how they are being administered. Completing this section required time on the producer or assessor’s part to read the product labels and verify how each is administered. This was a barrier to its proper completion and further modifications and additional testing are needed to make it a useful tool.

Assessment questionnaire

Each assessment question was worded such that if the producer was performing the prevention practice, he/she answered ‘yes’. There are limitations and advantages to this approach. First, a producer could figure out that the ‘right’ answer is always yes and answer accordingly in an effort to please the interviewer, regardless of actual implementation. This would increase the percent of false positives and decrease the likelihood of finding a correlation with milk production and quality parameters. Data analysis (Chapter 3) did not reveal a high percentage of yes responses for all operations.

Another drawback to this approach is that it did not quantify the probability of disease entry and the consequence like a true ‘risk assessment’. The risk management assessment did not evaluate single diseases for their probability of entering or spreading on a dairy given the wide variability of factors; the focus was on routes of disease transmission. Consequences of disease introduction or spread also varies by dairy due to differences in herd size, number of employees, age of facilities, genetic quality of livestock, and equity in the operation. Determining consequences was beyond the scope of the initial validation of this tool. However, if specific prevention practices are found to correlate with higher milk production and lower somatic cell count, their corresponding ‘assessment questions’ could be used in future studies with operations accounting for disease probability and consequences.

The benefits of using a risk management questionnaire formatted with all the questions written with the right answer being ‘yes’ included: 1) the ability to quickly gather dairy producer reported disease management practices applied on a dairy, and 2) serving as an immediate awareness education tool about recommended disease prevention practices. In a study by Cassel, et al, dairy producer's lack of awareness of management practices was a bigger problem than a lack of resources, technology or equipment.(Cassel et al., 1994) In the current study, as questions were asked, dairy producers learned what the recommended practice should be, regardless of their response. For instance, 'is your somatic cell count routinely under 200,000 cells/mL', allows producers to recognize what is regarded as the industry standard for milk quality. Even without a formal written report summarizing the findings, the assessment questions become an on-farm 'teachable moment'.

The goal of assigning routes to each assessment question was to provide another educational output. For instance, the question, 'do you require clean footwear on everyone entering your operation (visitors, service personnel)' is an example of managing disease introduction from fomites while 'do you avoid feeding leftover/uneaten feed from lactating animals to young stock' is an example of managing orally spread diseases. Some questions have multiple routes, such as 'do you separate sick cows (potentially contagious) from healthy cows ASAP' which accounts for aerosol, direct contact, and oral disease spread.

Reports as risk communication tools

Even though producers increased their awareness of disease prevention practices during the assessment process, a summary of vulnerabilities and strengths is another important educational and risk communication component. Effective communication is necessary for a successful biological risk management program. A program must be understood and supported by everyone to be effectively implemented and reports can help accomplish that goal.

Management recommendations

When writing the management recommendations, justification was a primary goal and practicality was a close second. By providing the reason for addressing the issue followed by the steps to readily apply it on farm, acceptance should increase.(Coreil et al., 2001) For instance the question, 'are cows kept on their feet for at least 30-45 minutes after milking to allow keratin plug formation in the teat canal?, was followed by the management recommendation, ‘teat ends remain open for 30-45 minutes after milking before the keratin plug forms; cows should be kept on their feet (offer fresh feed, keep water troughs available) during this time to minimize the risk of disease organisms entering the teat canal and causing an infection’. Also, ‘do you immediately freeze your colostrum if it will be stored for more than 24 hours in a labeled, sealed, single use container?’, had the following management recommendation, ‘colostrum is an excellent medium for bacterial growth (warm, moist, sugars for energy) and to minimize this, unfed colostrum should be packaged in clean, single use containers (sealed plastic baggies, palpation sleeves, half-gallon plastic bottles), labeled with cow ID and date, and frozen if it is not going to be fed for 24 hours or more’. These are examples of management recommendations with scientific justification and practical suggestions to accomplish the goal of decreasing disease spread on farm.

Customization was an important component of the BRM program. During the on-farm assessment process, assessors may identify additional information or areas of focus. The comments could include specific focus areas (the pen of bred heifers; hang a sign on the north entrance gate) or alert the dairy producer to an observed management practice (disposable boot box empty). Once entered into the database, the assessor has the option to print or hide the comments on the final management recommendation report. Effective disease management programs must be flexible to meet the needs of the individual dairy.(Wells, 2000) The built in functionality of the online database provided this flexibility while minimizing the time spent writing reports allowing for maximal education time on farm.

Prevention practices

Many dairy operations have numerous disease prevention practices in place despite a need for improvement in some limited areas. To recognize the strengths of a dairy’s biological risk management practices, the ‘yes’ responses generated a ‘Current Prevention Practices’ report. Developers agreed that praising good prevention practices was as important, if not more so, than identifying weaknesses.

Route graphs

The goal for the ‘Route Graph’ report was to reinforce the concept that disease control can be tailored based on how animals are exposed to disease, despite differences in assessment questions and segments of the farm (calves or dry cows). Combining the results of the ‘Route Graph’ report, the ‘Management Recommendations’ and the producer’s concern for specific diseases from the ‘Pre-Assessment Questionnaire’ provides the information needed to develop a disease management plan based on identified risks.

Conclusions

A multitude of resources were utilized in the development and testing of the dairy biological risk management materials. Educational information was gathered from a variety of publications to develop the documentation, assessment questionnaires, and risk communication materials. Developing an effective questionnaire involved peer review, formative evaluation and pilot testing in a variety of formats. Revisions were made to ensure the best information could be collected. The outcome of these efforts resulted in a user-friendly, readily accessible, free resource for dairy producers and their advisors to use to identify the risks to disease introduction and spread. Practical suggestions for disease management were included. Validation of these recommendations was still needed and is discussed in Chapters 3 and 4 of this dissertation.

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Chapter 3. Development, testing and descriptive results for the biological risk management (BRM) assessment of 80 dairies

Introduction

The dairy biological risk management (BRM) program has the goal of increasing dairy producer awareness of disease prevention practices. Educational materials were developed to identify and minimize the risk of disease entry and spread on dairy operations (Chapter 2). The collection of dairy BRM materials includes a document describing the scope of the dairy industry, the importance of disease risk management, and identifying risk based on how cattle are exposed to disease via five routes of transmission (aerosol, direct contact, fomite, oral and vector-borne). An online database was also developed to help producers and their advisors identify strengths and vulnerabilities on farm using risk management assessments based on the transmission route approach. Communication tools included various reports generated from responses to the assessments and handouts to guide improvements in a practical manner.

The dairy BRM materials were peer-reviewed and pilot-tested but there was still a need to identify which practices producers reported as being implemented on commercial dairies and if there was any correlation to positive herd outcomes such as higher milk production or lower somatic cell count. To accomplish this, a project was designed to test a portion of the risk management assessment questions on modern dairy operations in both California and the Midwest.

The goal of this chapter is to describe the development of the questionnaires used in the study of dairies of different sizes and management styles and report the descriptive results. One specific aim was to conduct on-farm assessments using questionnaires to identify milk production and quality parameters, management styles, perception of disease risk, and current biological risk management practices. Another aim was to disseminate risk communication tools to increase dairy producer awareness of disease prevention practices on dairy farms. The last aim was to analyze the cumulative results and report the similarities and differences in specific disease prevention practices and management characteristics.

Methods

Formative evaluation

In September 2005, Dr. Dale Moore, University of California, Davis, coordinated a dairy farm advisor meeting for the dissertation author to introduce biological risk management, review the BRM tools, enlist help with the project, and describe data collection procedures. The questionnaires had been previously tested on Midwest dairies but to ensure applicability to large western dairy herds, farm advisors were asked to review the 19 question, five-page dairy pre-assessment questionnaire (PAQ) and the 178 question, 12-page assessment questionnaire (AQ).

This team of California dairy farm advisors had prior experience surveying western dairy producers and felt that the questionnaires would be better accepted if shortened. A guideline of three pages for each questionnaire was deemed feasible for collecting data in a field situation. The vaccination table in the PAQ was considered cumbersome and the group did not think data could be acquired from the dairy producers. This group also commented they were not comfortable discussing zoonotic disease risks with the dairy producers and encouraged removing questions specifically addressing zoonoses. Based on these comments and personal experience using the questionnaires, each question was evaluated, inapplicable questions removed, and the questionnaires were customized for data collection on western and Midwestern dairy herds.

Testing the dairy BRM tool: California project

Dairy farm advisors representing the major dairy areas in the central valley of California were asked to collect data from five dairies each (30 total) beginning in January, 2006. Funding from the Department of Homeland Security, Foreign Animal and Zoonotic Disease Center was utilized as incentive for participation. Data collection instruments included a dairy pre-assessment questionnaire (PAQ), an assessment questionnaire (AQ), and a two-page form with 21 questions designed by Dr. Moore for the farm advisors to evaluate the use of the tools on farm (evaluation not included). The University of California, Davis Institutional Review Board (IRB) reviewed all questionnaires and communication tools and deemed them acceptable as written but not requiring human subject’s approval (exempt).

Requirements for dairy producer participation were a willingness to answer a series of questions, having a minimum of 100 head of adult cattle, and use of Dairy Herd Improvement testing for milk production and quality. Participants represented a convenience sample and did not receive payment. Farm advisors were given written recommendations for conducting the on farm evaluation. (Appendix 6) A copy of the dairy's most recent Dairy Herd Improvement (DHI) herd summary sheet containing the previous 12-months test results was requested.

All questionnaires were de-identified prior to submission; farm advisors assigned a random farm code to each form. Completed forms were submitted to a University of California technician for entry into the online BRM database (AQ) and an Excel® spreadsheet (AQ, PAQ, Evaluation).

Testing the dairy BRM tool: Midwest project

In October 2006, the dissertation author introduced the concept of biological risk management and the data collection project was described to five extension dairy specialists in Iowa. Each specialist was asked to collect data from eight dairies beginning in January, 2007. Two attendees were professors at Iowa State University who requested student involvement in the project. Funding for the dairy field extension specialists was provided from the Center for Food Security and Public Health at Iowa State University as participation incentive. The same information was provided to seven undergraduate Iowa State University students in the *Applied Dairy Farm Evaluation* course in January, 2007, and 18 fourth-year veterinary students in the *Introduction to Dairy Production Medicine* course in May 2007. These students collected data from farms in groups as part of their class assignment for their respective courses.

The same requirements for dairy producer participation applied to the Midwest project: willing to answer a series of questions, having a minimum of 100 head of adult cattle, and use of Dairy Herd Improvement testing for milk production and quality. Participants represented a convenience sample and did not receive payment. All data collectors were provided written recommendations for conducting the on farm evaluation. (Appendix 6) A copy of the dairy's most recent DHI herd summary sheet was requested. All Midwest dairy data collectors used the same PAQ and AQ as designed for the California project. The evaluation form developed by Dr. Moore was not used in the Midwest project. The Iowa State University Institutional Review Board (IRB) reviewed all questionnaires and communication tools and deemed them acceptable as written but not requiring human subject's approval (exempt).

All questionnaires were de-identified prior to submission; data collectors assigned a random farm code to each form. Completed forms were submitted to the dissertation author in Iowa for entry into the online BRM database (AQ) and an Excel® spreadsheet (AQ, PAQ).

Results

Risk management assessment – study questionnaires

Pre-assessment questions

The pre-assessment questionnaire (PAQ) was modified by the dissertation author to include housing options for western dairy facilities (dry lot, free stalls with access to exercise lot). A question with subparts was added to collect milk production data and variables that affect milk production or quality (projected mature equivalent 305 day milk, standardized 150-day milk, days in milk, somatic cell count, and cull rate). Inclusion of a copy of the Dairy Herd Improvement (DHI) herd summary sheet was requested. A question was added pertaining to the percent of the herd given bovine somatotropin (bST) and if it was given per label directions (start at 63 days in milk, given at 14 day intervals). Finally, the question, 'are you interested in learning about additional resources to help you manage those risks' was added to gauge producer interest in addressing the vulnerabilities identified through the risk management assessment. The end result was a three-page PAQ with 14 open-ended questions pertaining to herd demographics, production parameters, animal introduction, visitor protocols, isolation facilities and risk perception. (Appendix 7) A copy of the DHI herd summary sheet was requested to accompany the PAQ production information.

Assessment questions

The assessment questionnaire (AQ) was reviewed by the dissertation author and the 178 questions categorized into three main areas at the farm level: disease entry, disease spread, and calf management. The questions were also categorized by their routes of transmission at the animal level: aerosol, direct contact, fomite, oral, vector, zoonotic and combinations. Based on questionnaire format, a three-page document contained 45 questions (15 per page). The first assessment questions retained in the study questionnaire were those with scientific evidence for reducing disease introduction and/or spread on dairy operations. This resulted in 14 questions with representation in the farm level categories of disease entry (six), disease spread (seven), and calf disease management (one) and each of the animal level or route categories (aerosol-three, direct contact-four, fomite-ten, oral-six, vector-two, zoonotic-two).

The remaining 21 questions were selected to ensure representation in each of the following topics: animal contact, visitor/employee protocols, hygiene, milking procedures, colostrum and calf management, and feed and manure handling. The routes of transmission and disease entry/spread/calf management categories were considered in the final decision to keep or cull questions. Equal representation in each category was not possible given the combination of routes per question.

The final three-page assessment questionnaire utilized in this study consisted of 45 closed-ended questions that proportionally accounted for farm level practices and a variety of animal level (route of transmission) practices.(Appendix 8) There were no primary zoonotic questions but other questions considered this route in combination with other routes.(Table 1)

Table 1. Distribution of question categories by farm level and animal level (route of disease transmission) included in the final 45 question assessment questionnaire utilized in the study of California and Midwest dairy operations. Some questions included multiple routes of transmission.

45 Assessment Questions			
Farm level	**%**	**Animal level (route)**	**%**
Disease entry	26.7	Aerosol	31.1
Disease spread	53.3	Direct contact	57.8
Calf disease mgt	20.0	Fomite	44.4
		Oral	68.9
		Vector	26.7
		Zoonotic	17.8

Data collection

Interviews were conducted in person on the dairy operation as a way to establish the importance of the study with the producer. Assessors were trained on how to read the questions and conduct the interview. Assessors were discouraged from answering for the dairy producer and guided to record ‘maybe’ as the response when the dairy producer hesitated or provided a lengthy explanation instead of a ‘yes’ or ‘no’ response.

California project

The initial goal of 30 dairies was exceeded; dairy farm advisors completed a total of 40 questionnaires between January and June 2006. The de-identified assessment questionnaires and herd summary sheets were sent to one technician in California for entry into an online database. The University of California technician provided the farm advisors with the final reports generated from response entry into the online database: management recommendations with comments, prevention practices, and route graphs. Dairy farm advisors in turn provided the final reports to the dairy producers.

DHI herd summary sheets were provided for 11 herds. No information was provided for the production variable, standardized 150-day milk. In all, 34 Holstein herds, five Jersey herds and one mixed herd were included. A mixed herd was one with less than 75% of the herd consisting of the same breed. This could consist of 70% pure Holstein and 30% pure Jersey, or an entire herd of cross-bred animals. (Greg Palas, personal communication) Other results are provided in Chapter 4, ‘Biological risk management practices associated with milk production and quality’.

Midwest project

The same project conducted in California was repeated in the Midwest. A total of 40 questionnaires were completed between January and June 2007. The de-identified assessment questionnaires and herd summary sheets were sent to the dissertation author in Iowa for entry into an online database. The dissertation author also provided the data collectors with the final reports generated from response entry into the online database: all responses, management recommendations with comments, prevention practices, and route graphs. The professors of the courses where students collected data provided the final reports to the dairy producer.

Written interpretations of the results were provided to the dairy field extension specialists for their respective completed questionnaires. When a particular route(s) was identified as a vulnerability, or to address the producers' concerns of disease risk on farm, risk communication handouts (e.g., Fomites: Managing them to Minimize Disease Spread, Fly Control Measures, etc) were also included in the e-mail.

DHI herd summary sheets were provided for 27 Midwest herds. In all, 30 Holstein herds, two Jersey herds, one Guernsey herd, and seven mixed herds were included. Other results are provided in Chapter 4, 'Biological risk management practices associated with milk production and quality'.

Data processing and analysis

Copies of all de-identified PAQ, AQ and forms were submitted to the dissertation author and entered into a spreadsheet program (Microsoft Excel™, 2003). The spreadsheet data for the AQ were compared to results from the online BRM database and those entered by the technician in California to ensure congruency. This step was important to prevent loss of data during the transfer process. Despite this step, missing data points were identified and data collectors were contacted to provide additional details where possible. Responses from the AQ were recoded into categorical (nominal) data and exported for further analysis into JMP® 7.0.2 (SAS Institute Inc., Cary, NC).

Production values were based on the most reliable information available. For the 38 herds with a DHI herd summary sheet, the values for projected mature equivalent 305 day milk, standardized 150 day milk, days in milk, somatic cell count, and cull rate from that report were entered into the spreadsheet. Due to the different breeds included in the study, percent fat and protein were also recorded from the DHI herd summary sheet. For the 42 farms without herd summary sheets, the same production data points were taken from the data on the pre-assessment questionnaire. Fat and protein values were not available for this subset of dairies.

More than 135 variables were analyzed and descriptive statistics were generated for all informative data. Response frequency was evaluated for all assessment questions. Within-group means, medians and ranges for all continuous variables were calculated. Between-group differences were evaluated using t-tests and considered significant at $p<0.05$ with 95% confidence. Data from the PAQ were combined with the AQ to create informative indices where applicable.

Descriptive results

Herd size ranged from 92 to 3,550 head (average 772). There were 64 Holstein herds, seven Jersey herds, one Guernsey herd and eight mixed herds. The average herd size in the study was larger for California than Iowa and both were larger than the state average herd size. However, the percent of eligible DHI herds in this study from each state was similar despite the differences in total number of cows on DHI test. (Table 2)

Table 2. Average herd size and dairy cow enrollment in Dairy Herd Improvement (DHI) All Plans as of January 1, 2007 [b] by state in the biological risk management (BRM) study vs. state total.

State	Ave. BRM Herd Size (range)	2006 Ave. Herd Size [a]	Total DHI Herds[b]	BRM Cows	Total DHI Cows[b]	Percentage of eligible DHI herds
40 Calif. Herds	1061 (145-3550)	908	946	42,456	979,917	4.23%
39 Iowa Herds	482 (92-2985)	92	940	19,279	120,784	4.25%
80[c] Total Herds	772 (92-3550)		23,611	61,735	4,243,205	0.3%

[a] Source (Progressive Dairyman, 2007)
[b] Source (ARS, 2007a)
[c] One dairy operation in Illinois, not included in state averages

Production and quality parameters

Data were collected for a variety of milk production parameters including 305 day mature equivalent (ME), days in milk (DIM), somatic cell count (SCC), milking frequency for lactating and fresh cows, and the use and percent of the herd on bovine somatotropin (bST). (Tables 3, 4) Standardized 150-day milk values were provided by the 40 Midwest dairies and ranged from 56.2 to 97.0 (median 80.85); no data were provided for the California dairies. Cull rate for the 80 dairies ranged from 4.8 to 59.0% (median 32.4%); two herds had missing values. Data were not collected on the culling reasons.

Table 3. Milk production parameters for all 80 herds and by region.

Production parameters	**All Herds (n=80) median (range)**	**California (n=40) median (range)**	**Midwest (n=40) median (range)**
305 day mature equivalent (ME) (lbs)	24,313 (15,564-30,586)	24,236 (15,564-30,586)	24,454 (17,375-29,276)
Somatic cell count (SCC) x 1,000	259 (110-954)	250 (110-474)	295 (124-954)
Days in milk	190 (94-250)	190[a] (162-225)	193 (94-250)
Milking frequency per day (fresh cows only)	56 herds 2X 16 herds 3X 7 herds 4X 1 herd 6X	24 herds 2X 11 herds 3X 4 herds 4X 1 herd 6X	32 herds 2X 5 herds 3X 3 herds 4X 0 herds 6X
Milking frequency per day (all cows)	54 herds 2X 26 herds 3X	23 herds 2X 17 herds 3X	31 herds 2X 9 herds 3X
Bovine somatotropin (bST) use in herd	52.5%	40%	65%

[a] Three herds did not report DIM

Of the 42 herds incorporating bST as part of their management program, 36 were Holstein herds. Only half (21) administered it per label directions and usage on the eligible lactating cows ranged from 10 to 100% (median 60%). Herds using bST were evaluated for the effect on production (305ME), DIM and SCC and the difference compared to non-bST herds. There was no statistical difference in production or DIM between the two groups. However, herds using bST had a statistically significant higher SCC than non-bST herds ($p < 0.0226$). (Table 4) Removing the two outlier herds, defined as greater than two standard deviations from the mean, (SCC of 621,000 and 954,000) still demonstrated a tendency for an association, despite a decrease in statistical significance ($p<0.0574$; data not shown).

Table 4. Student's *t*-test for a difference in the means of milk production and quality parameters for dairy herds using and not using bovine somatotropin (bST).

Production parameters	**42 bST Herds mean (range)**	**38 Non-bST Herds mean (range)**	**Difference (p value)**
305 day mature equivalent (ME) (lbs)	24,594 (16,500-30,339)	23,582 (15,564-30,586)	1012.0 (0.1719)
Somatic cell count (SCC) x 1,000	314.857 (120-954)	251.732 (110-553)	63.126 (0.0226)**
Days in milk	195.7[a] (165-227)	187.2 (94-250)	8.5 (0.0712)
Herd size	842 (108-2985)	694 (92-3550)	148 (0.3688)

[a] Three herds did not report DIM; ** Significant at p<0.05, 95% confidence interval

A copy of the DHI herd summary sheet was provided by 38 herds. For those provided, testing centers included AgriTech Analytics, AgSource/WisGraph, Dairy Record Management Systems (DRMS), Minnesota, and Provo DHIA. Some type of record keeping for individual cows (health/prevention) was reported for 77 herds. The type of records were not exclusive and the two most common types were DHIA – monthly and treatments (52 herds) followed by vaccinations (48 herds), on-farm production software, Dairy Comp 305 (29 herds), DHIA – plus (9 herds) and DHIA – bi-monthly (5 herds). A variety of 'other' records were reported including PCDART and reproduction/breeding.

New introductions

Data were collected from the 80 dairies pertaining to the numbers, frequency and type of animal(s) newly introduced to the herd. Twenty-four herds did not report introducing any animals in the past year, 19 herds introduced one to 10 animals, four introduced 11-20 head, 10 herds introduced 21-50 head, nine herds introduced 51-150 head, and 14 herds introduced 250-2000 head. The type of animal and frequency of introduction varied. (Table 5)

Larger numbers of bred heifers, dry and lactating cows were introduced by herds noted as expanding. Some herds sent calves to a heifer raiser and reported them as new introductions when they returned as yearlings or as bred heifers. Bulls were introduced yearly for 12 of the herds. Of the 56 herds that introduced animals, animal type by herd size was evaluated. (Table 6) Some herds introduced multiple animal types in the same year.

Table 5. Number of newly introduced animals reported by herd, by animal type and frequency for the 80 dairy herds.

Type	No. Head Per Week	No. Head Per Month	No. Head Per Year
Heifers, 0-12 mos.	12 (1 herd)	1 to 50 (6 herds)	1 to 80 (9 herds)
Bred heifers, 13-22 mos.	7 to 10 (3 herds)	1 to 100 (15 herds)	6 to 2000 (12 herds)
Dry cows	None	None	9 to 347 (3 herds)
Lactating cows	1 to 10 (2 herds)	5 (1 herd)	10 to 250 (5 herds)
Bulls	None	None	1 to 50 (12 herds)

Table 6. Percentage of operations that introduced various types of animals in the previous year, by herd size. Some herds introduced multiple types in the same year.

	Percent Operations by Herd Size (Number of Herds)		
Type	**Small (92-505)** n=32	**Large (>506)** n=38	**All Operations** n=70
Heifers, 0-12 mos.	18.8	26.3	22.9
Bred heifers, 13-22 mos.	43.8	42.1	42.9
Dry cows	6.3	2.6	4.3
Lactating cows	12.5	13.2	12.9
Bulls	18.8	15.8	17.1

Isolation and quarantine

Immediately after asking about bringing in new animals, dairy producers were asked if they had isolation facilities, how long animals are kept there, on average, and what, if any, tests for diseases were conducted. A definition of the term ‘isolation’ was not given during the assessment. Eighteen herds (22.5%) reported utilizing isolation facilities; of those, 14 herds reported length of time in the facility ranging from two to 90 days (median 14 days). Four of the 18 herds (22%) reported testing for the following diseases while in isolation: Johne’s, tuberculosis, bovine viral diarrhea (BVD), brucellosis, mastitis, parainfluenza 3 (PI_3), and bovine leukosis virus.

Producers were also asked the closed-ended question, ‘do you have an area used only for quarantine for newly introduced animals?’ Thirteen reported they utilized a quarantine area and 13 skipped the question because they did not introduce new animals. Details specific to the quarantine area were not collected. The results of the isolation and quarantine questions were combined and analyzed because length of time and testing information was provided for herds who reported they did not utilize isolation facilities. (Table 7)

Table 7. Comparison of the number of herds that reported quarantine and/or isolation by length of time and tests for diseases.

Prevention Practice	No. of Herds	Median Time (range)	Reported Tests for Diseases
Isolation (Yes) Quarantine (Yes)	9	2 weeks (2 to 30 days)	Tuberculosis (TB) Johnes, brucellosis, bovine viral diarrhea (BVD), bovine leukosis virus (BLV)
Isolation (Yes) Quarantine (No)	6	1 week (7 to 90 days)	BVD, parainfluenza 3 (PI_3), Johnes Prior to delivery: *Staphlycoccus aureus*, TB, BVD
Quarantine (Yes) Isolation (No)	4	Not reported	Johne's
Isolation (No) Quarantine (No)	48	Not reported	Somatic cell count, BVD; Prior to delivery: TB, brucellosis, BVD, Johnes, BLV

Returning animals

The majority of herds (60%) allowed an animal to return to the farm at least once a year. Of those, 17 herds frequently (monthly) allowed animals to return, while 10 sometimes (3-6 times/year) permitted it. Of the 80 herds, 24 did not report introducing new animals. However, 11 of these herds had at least one animal leave and re-enter the dairy herd in the past year. (Table 8) Reasons for leaving and re-entering were not collected but the examples given during the assessment included livestock shows, veterinary clinic or embryo transfer.

Table 8. Frequency of animals re-entering the 24 dairy operations that did not report introducing new animals, including reported isolation and testing protocols.

Frequency of re-entry	% Herds	Quarantine Newly Introduced?	Isolation Reported	Testing Reported
Never	54.2%	Skipped	1 herd for 1 week 1 herd for sick only	Mastitis
Rarely (1-2 times/year)	25.0%	No	1 herd for unreported 1 herd for sick only	None
Sometimes (3-6 times/year)	4.2%	Yes	None	None
Frequently (monthly)	16.7%	No	1 herd for 1 week	None

Animal contact

Producers were asked questions related to animal and employee contact with other livestock, whether the other livestock were alive or dead. (Table 9)

Table 9. Producer-reported animal contact prevention practices on the 80 dairy operations (unless otherwise noted).

	Responses	
Question	**Yes**	**%**
Are your cows kept away from fence to fence contact with other livestock?	52[a]	67.5%
Do you limit nose to nose contact between animals from different stages and/or age groups?	38	57.5%
If animals are rendered, is the pickup area located on the perimeter and away from all other entrances to your operation?	32[b]	50.8%
Do you request that your employees avoid contact with livestock outside of your operation?	16	20.3%

[a] Three operations did not respond to this question
[b] Seventeen operations did not respond to this question; assessor comments included operations composted or did not use rendering service

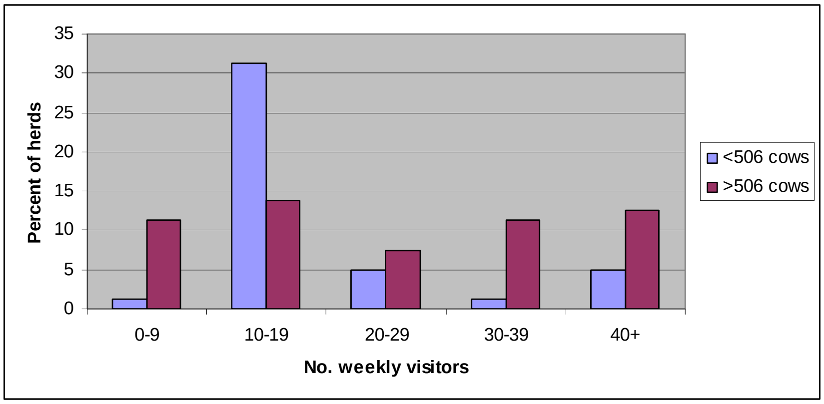
Visitors

Dairy producers were asked to quantify the number of weekly visitors and describe any protocols implemented on farm. Forty-five percent of all farms reported 10-19 visitors per week. Fifteen percent of all farms reported $\geq$40 visitors per week. (Table 10) The number of visitors by herd size was also evaluated. (Figure 1)

Table 10. Number of weekly visitors reported for each pre-determined category for all 80 herds and by region.

Visitors	All Herds (n=80)	California (n=40)	Midwest (n=40)
0-9	10	1	9
10-19	36	14	22
20-29	10	6	4
30-39	10	9	1
40-49	3	2	1
50-59	6	5	1
60-69	2	2	0
70-79	2	0	2
80-89	1	1	0

Figure 1. Percent of herds with weekly visitors in each pre-determined category by herd size for 80 dairy herds.

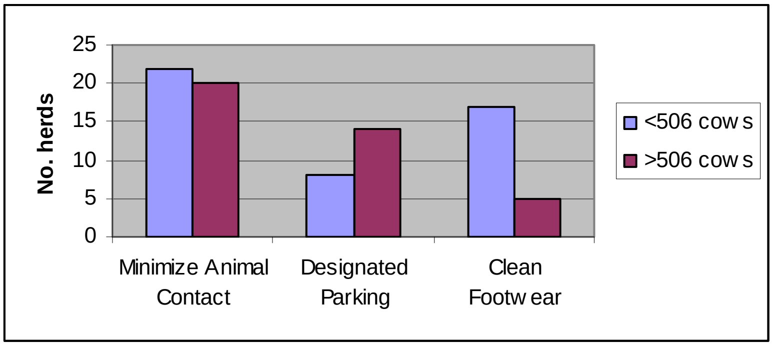


Despite the large number of visitors to the dairy, only 24 operations described protocols for visitors. Examples given included requiring boots (disposable, clean or farm specific) worn on farm, signs designating where people can go (restricted to office, by appointment only, no unauthorized entry), prohibiting visitor access to cow areas, visitor log, and guided tours. These results were combined with the six closed-ended questions that focused on people traffic on the dairy operations. (Table 11) The three most reported practices were analyzed by herd size. (Figure 2)

Table 11. Producer-reported prevention practices for visitors on the 80 dairy operations.

	Responses (n=80)	
Question	**Yes**	**%**
Do you have a visitor protocol? If yes, describe it. (open ended)	24	30.0%
Do you minimize animal contact with anyone entering your operation?	42	52.5%
Do you have a designated visitor and employee parking area?	22	27.5%
Do you require clean footwear on everyone entering your operation?	22	27.5%
Do you require clean clothes on everyone entering your operation?	14	17.5%
Are signs posted and very visible restricting access to your facility to anyone not employed by the operation?	13	16.3%
Do you require visitors to sign in and disclose their last known cattle contact?	3	3.8%

Figure 2. Comparison of the three most producer-reported visitor protocols by herd size for the 80 dairy herds.



Adult cattle housing

Housing demographics were obtained for adult cattle on the 80 dairies. Dry and pre-fresh cows were not differentiated in the assessment; data on number of head and housing type were grouped together. (Table 12)

Table 12. Number of animals (group size) and percent of herds by primary housing type for the dry/pre-fresh and lactating cows on the 80 dairy operations.

Number of Head	**Dry Cows/Pre-fresh**	**Lactating**
Range	4 to 700	86 to 2850
Median	74	435
Mean	111	661
Primary Housing	**% of Herds**	**% of Herds**
Barn	35.0	1.25[a]
Bedded pack/compost barn	0	6.25
Dry lot	60.0	20.0
Pasture	3.75	6.25
Free stalls only	1.25	46.25
Free stalls with exercise access	0	20.0

[a] Stanchion

Producers were asked about how they maintained the dry lot area, alleys and stalls. (Table 13)

Table 13. Maintenance of animal housing and traffic areas on the 80 dairy operations (unless otherwise noted).

	Responses	
Question	**Yes**	**%**
Is the dry lot area regularly maintained to prevent manure buildup and areas of stagnant water?	60	80.0%
Do you keep your stalls clean (scraped at least one time daily)?	60[a]	92.3%
Do you keep your alley ways clean (scraped or flushed at least one time daily)?	70	87.5%

[a] Fifteen operations did not respond to this question; all were dry lot dairies

Vector control

Producers were asked about the presence and maintenance of control programs for flies, other pests. (Table 14)

Table 14. Presence and maintenance of fly, other pest control programs on the 80 dairy operations (unless otherwise noted).

	Responses	
Question	**Yes**	**%**
Do you have a fly control program?	65	81.3%
Do you have a set schedule and designated person to check all pest control programs to ensure they are kept current?	40[a]	51.3%

[a] Two operations did not respond to this question

Udder health

Various factors that affect udder health and milk quality were collected. (Table 15) Data was analyzed regarding average SCC for herd introducing various animal types. (Table 16)

Table 15. Udder health and milk quality practices on the 80 dairy operations.

	Responses	
Question	**Yes**	**%**
Are cows kept on their feet for at least 30-45 minutes after milking to allow keratin plug formation in the teat canal?	40	50.0%
Is your somatic cell count routinely under 200,000?	21[a]	26.3%
Do you use a CMT[b] paddle on individual cows to monitor for mastitis?	29	36.3%

[a] Sixteen operations (20%) had actual SCC $\leq$200,000
[b] California mastitis test (CMT)

Upon further evaluation, six false positive herds (said yes, SCC is routinely under 200,000) had an average SCC of 248,666 cells/mL. One false negative herd (said no to SCC is routinely under 200,000) had an actual SCC of 200,000. However, student's *t*-test for the difference in the means of actual SCC between those answering yes vs. no was significant at $p<0.0001$ (data not shown).

Table 16. Average somatic cell count (SCC) for the 56 herds that reported newly introduced animals, by animal type and number of herds. Some herds introduced multiple types in the same year.

Type	Average SCC	No. Herds
Heifers, 0-12 mos.	241,925	16
Bred heifers, 13-22 mos.	300,227	30
Dry cows	321,333	3
Lactating cows	386,625	8

Animal health

A variety of disease prevention practices regarding how producers handle animal health related issues were collected. (Table 17)

Table 17. Animal health practices on the 80 dairy operations (unless otherwise noted).

	Responses	
Question	**Yes**	**%**
Do you investigate animals that will not eat or do not consume all of their feed?	76	95.0%
Are animals that are not going to recover euthanized humanely and promptly?	74[a]	93.7%
Are all animals inspected daily for signs of illness?	72[a]	90.0%
Do you keep treatment records for all animals?	63	78.8%
Do you separate sick cows (potentially contagious) from healthy cows ASAP?	59	73.8%
Do you have a veterinarian necropsy all animals that die from undetermined causes?	13	16.3%

[a] One operation did not respond to this question

The results of the question, 'do you separate sick cows…' were combined with the number of operations that reported having isolation facilities. Of the 59 herds reporting the separation of sick cows as soon as possible (ASAP), only 20.3% had isolation facilities.

While 21 herds reported they did not separate sick cows ASAP, 23.8% had isolation facilities.

Feed and water

Quality assurance practices pertaining to the handling of feed and water on dairies were collected. (Table 18) Of the 17 operations that did not use different equipment for feed and manure handling, 64.7% agreed with the statement that they cleaned all manure off the bucket and tires and disinfect before using for feed.

Table 18. Feed and water quality assurance practices on the 80 dairy operations.

	Responses	
Question	**Yes**	**%**
Do you examine all feedstuffs closely for manure, mold, foreign material, and overall quality?	76	95.0%
Do you use different equipment for feed and manure handling?	63	78.8%
Do you clean water troughs/cups frequently (at least weekly)?	57	71.3%
Are your pen entrances designed to prevent people from stepping into the feed bunk?	44	55.0%

Heifer management

Assessment questions related to calf management included handling newborns, colostrum management, numbers raised on farm, types of housing, and minimizing exposure to other animals and their manure.

Newborn calves and colostrum

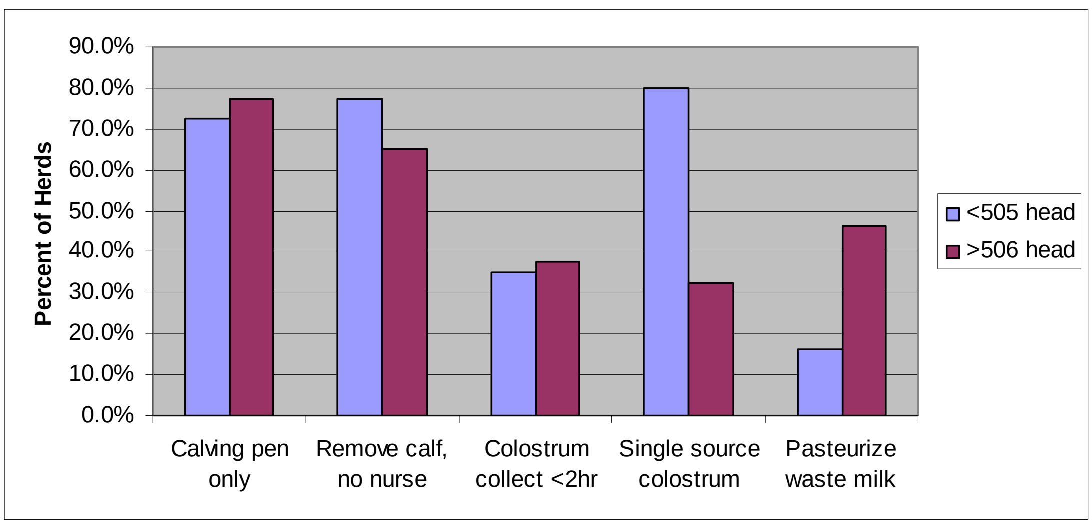
Dairy producers were asked about calving and colostrum feeding protocols. (Table 19) Five protocols were further evaluated by herd size. (Figure 3)

Table 19. Calving and newborn calf protocols on the 80 dairy operations (unless otherwise noted) presented in the order they were asked during the assessment.

	Responses	
Question	**Yes**	**%**
Do you limit your calving area to calving only and not for isolation animals?	60	75.0%
Do you remove calves from mothers at birth, not allowing them to nurse?	57	71.3%
Do you collect colostrum within first 2 hours after calving?	29	36.3%
Do you immediately freeze colostrum if stored for more than 24 hours in a labeled, sealed, single use container?	32	40.5%
Do you only use single source colostrum, not pooled from multiple cows?	45	56.3%
Do you give ¾ to 1 gallon of colostrum within the first six hours of life?	59	73.8%
Do you give a second dose (1/2 to ¾ gallon) of colostrum 12 hours later?	62	77.5%
Do you pasteurize waste milk before to feeding to calves?	17[a]	34.7%

[a] Thirty-one operations did not respond to this question; fed milk replacer or did not raise pre-weaned calves

Figure 3. Percent of herds reporting newborn calf protocols on 80[a] dairy operations, by herd size.



[a] Pasteurized waste milk: $\leq$505 head based on 25 herds; >506 head based on 28 herds

Heifers raised on farm and housing

Data were collected for four heifer groups with specified age ranges: pre-weaned (0-2 months), weaned (3-8 months), pre-bred (9-12 months) and bred (13-22 months). Of the 80 dairies, four herds raised all of these phases off site (all Midwest herds, average herd size 1,492). One California operation (2,575 head) raised the first three phases off site. The Midwest dairies were more likely to raise weaned heifers and older off site. (Table 20) Reasons for raising heifers off site were not collected.

Details related to retained ownership of heifers were not collected but producers were asked, ‘is the origin of all replacement heifers known?’ Of the 80 dairies, 86.3% agreed with this statement. The four Midwest dairies that raised all four phases off-farm stated they knew the origin of all their heifers.

Table 20. Percent of the 80 dairy operations that raised heifers off site, number of herds by location and herd size.

Heifer Class	**% Operations (n=80)**	**Location (# of herds)**		**Herd Size (# of herds)**	
		California	**Midwest**	**≤505 cows**	**>506 cows**
Pre-weaned (0-2 mos)	21.3	12	5	2	15
Weaned (3-8 mos)	15.0	4	8	4	8
Pre-bred (9-12 mos)	18.8	4	11	7	8
Bred (13-22 mos)	16.3	2	11	7	6

For the operations that raised calves, number of head and primary housing type for the four phases of heifers were collected. Producers also reported whether the animals were raised individually or as groups. (Table 21)

Table 21. Number of dairy operations raising heifers by phase and primary housing.

Number of:	**Pre-weaned** (0-2 mos.)	**Weaned** (3-8 mos.)	**Pre-bred** (9-12 mos.)	**Bred** (13-22 mos.)
Operations	63	68	65	67[a]
Head (range)	4 to 300	3 to 900	15 to 1260	6 to 850
Head (average)	68	150	127	196
Primary Housing:	Individual: 57 herds Group: 5 herds	Groups: all	Groups: all	Groups: all
Hutches	43	0	0	0
Barn	7	2	11	11
Pen	13 (7 solid; 6 mesh panels)	26	0	0
Dry lot	0	37	44	49
Pasture	0	3	10	6

[a] One operation did not report housing

Minimizing young stock exposure to manure

Prevention practices related to minimizing exposure of young stock to manure were collected. (Table 22)

Table 22. Prevention practices aimed at minimizing manure exposure to young stock on farm for the 80 dairy operations (unless otherwise noted).

	Responses	
Question	**Yes**	**%**
Do you prevent young animals from coming in contact with manure from older animals?	56	70.0%
Do you utilize individual calf housing for newborn calves and ensure there no direct contact between them?	44[a]	62.0%
Do you avoid feeding leftover/uneaten feed from lactating animals to young stock?	38	47.5%
During chores, do you move from “clean” younger animals to “older” animals, to “dirty”/sick animals, and finally isolation animals?	31	39.7%
Are employees required to clean and disinfect their boots when moving into special areas of the farm, such as the maternity and calf areas?	10	12.5%
Are employees required to change clothing when moving into special areas of the farm, such as the maternity and calf areas?	1	1.3%

[a] Nine operations did not respond to this question

Biological risk management practices

The management practices that less than 20% of the dairy operations were doing included requesting that their employees avoid contact with livestock outside of the operation (18.7%), requiring clean clothes on everyone entering their operation (visitors, service personnel) (18.4%), posting visible signs restricting access to their facility to anyone not employed by the operation (17.1%), having a veterinarian necropsy all animals that die from undetermined causes (17.1%), requiring employees to clean and disinfect their boots when moving into special areas of the farm such as the maternity and calf areas (11.8%), requiring visitors to sign in and disclose their last known cattle contact (3.9%), and requiring employees to change clothing when moving into special areas of the farm such as the maternity and calf areas (1.3%).

On the other hand, the management practices that 80% or greater of the dairy operations were doing included examining all feedstuffs closely for manure, mold, foreign material, and overall quality (95%), investigating animals that will not eat or do not consume all of their feed (95%), humanely and promptly euthanizing animals that are not going to recover

(93.7%), keeping stalls clean (scraped at least one time daily) (92.3%), inspecting animals daily for signs of illness (90.0%), keeping alley ways clean (scraped or flushed at least one time daily) (87.5%), knowing the origin of all replacement heifers (86.3%), having a fly control program (81.3%), and regularly maintaining the dry lot area to prevent manure buildup and areas of stagnant water (80.0%).

Risk perception

To ascertain the perceived risk(s) on farm, producers were asked the open-ended question, ‘what disease(s) are you most worried about occurring at your facility?’ and ‘what do you perceive as the biggest disease risk/challenge for your facility?’ These questions were very similar in their wording and there was some overlap in producer responses. There were also some notable comments that demonstrated producers worry about things that were not necessarily a current disease risk or challenge.

The top three diseases producers were worried about included Johne’s disease (31 herds), BVD (23 herds), and foot and mouth disease (FMD) (13 herds). Mastitis in general was reported by 15 herds, and when combined with all reported types including *Mycoplasma* (12), *Staphylococcus aureus* (five) and *E. coli* (two), it totaled 40 herds.

The top three responses for the biggest perceived disease risk/challenge included mastitis – all types (30 herds), FMD (11 herds), and Johne’s disease (nine herds). *Salmonella* and foot warts (papillomatous digital dermatitis- PPD) were tied for fourth most reported (six herds each). Notable comments included the risk of people introducing disease onto the farm and new animals from different herds.

Finally, producers were asked, ‘are you interested in learning about additional resources to help you manage those risks?’ and 87.5% answered yes. Three operations did not answer. Average herd size for operations interested in more information was 772 head compared to 802 for those producers who were not interested, which was not statistically different.

Discussion

The purpose of an effective biological risk management program on a dairy operation is not one of complete disease exclusion, as that is not practical for most domestic cattle diseases. Rather, the goal is to increase dairy producer awareness of the many ways in which diseases can enter or spread on a dairy operation. With this information, dairy producers can make informed decisions based on their tolerance of disease risk.

The BRM assessment questions and corresponding recommendations were aimed at minimizing the infectious burden on a dairy operation. By decreasing the amount of infectious pathogens through proper hygiene of people, equipment, and housing, chances of exposure are decreased. Combined with management factors that minimize animal stress and improve immunity, reducing pathogen exposure will reduce the number of animals becoming clinically ill, allowing production performance and the economic viability of the dairy to be maintained.

Utilizing questionnaires to discover management practices on dairies are common.(Keown, 1988b; Jordan and Fourdraine, 1993; Losinger and Heinrichs, 1996; USDA, 1996; USDA, 2002; USDA, 2007a) However, this is the first study that utilized a risk analysis approach on individual dairy operations. Although this study did obtain disease risk perception, milk production, milk quality, herd demographic information, and producer-reported disease control practices, it did not obtain information to estimate probability of disease introduction or consequences as a true risk assessment would. The focus of the study was to increase awareness of risky management practices and evaluate how the assessment tools performed.

Generalizing the findings in this study to all U.S. dairy herds should be done with caution. The population was a convenience sample; randomized selection would have made results more externally valid. Data were collected by third-party assessors using a risk management questionnaire with dairy producers who voluntarily participated. In addition, actual implementation of practices may or may not have been observed, making the results subject to reporting bias. While assessors received the same training and the assessments had been pre-tested, more than 11 people were responsible for collecting data, with the potential for interviewer bias.

Production and quality parameters

Milk production and milk quality parameters were collected that could be compared across 80 U.S. dairy herds. Despite reviewing various DHI herd summary sheets prior to selecting production variables, California dairy producers were not familiar with the term 'standardized 150 day milk'. Data were only available from the 40 Midwest dairies; thus the variable was disregarded in the final analysis. Management level milk (MLM) would have been a more standardized term to include.

Milk production and quality can be affected by breed, genetics, milking frequency, feed quality, water availability/quality, environmental temperature, parity, and the herd average number of days in milk.(Jordan and Fourdraine, 1993; Barkema et al., 1999b; Oleggini et al., 2001b; Kellogg et al., 2001b; Smith et al., 2002b; Lievaart et al., 2007) The use of recombinant bovine somatotropin (rbST) use can also affect milk production and milk quality.(Soderholm et al., 1988; Oldenbroek et al., 1993) This project examined production parameters on a herd level so that genetic information on each cow in each herd was not a confounder. Parity information (percent of first lactation animals) would have been available if all 80 herds would have provided a DHI herd summary sheet. Feed quality and water availability are important determinants to production performance but were not collected in this evaluation. The goal was to obtain readily available herd level variables so that the study could be repeated without extensive financial resources and time investment in the future.

The DHI herd summary sheet could have provided missing production values but compliance with this request was only 47.5%. Three herds had missing values for DIM and it is unknown if this would have affected the mean for the recombinant bovine somatotropin (bST) herds. There was no significant difference in milk production or days in milk for herds reporting bST use compared to herds that did not. This result could be due to sample size or other, potential confounding factors not obtained. There was, however, a significant difference in milk quality; SCC was higher in herds that utilized bST. While elevated SCC is an indicator of udder health, rates of clinical mastitis were not obtained in this study. Oldenbroek et al., reported higher SCC in cows treated with bST.(Oldenbroek et al., 1993) However, many factors can affect udder health and further analysis of the relationship of management practices to SCC is needed before making conclusions on this observation.

New introductions

Across all herd sizes, bred heifers were the most common class of animal introduced, similar to results of the 2007 NAHMS study. (USDA, 2007a) The next most commonly introduced group was heifers aged 0 to 12 months. A higher percentage of small herds introduced bulls as compared to large herds. Newly introduced animals, particularly adult cattle, have been a source of disease introduction to dairy herds.(Losinger and Heinrichs, 1996; Vaessen, 1998; Faust et al., 2001; van Schaik et al., 2002; Nielsen et al., 2007) Any animal of a different origin with varying vaccination and exposure status poses a disease introduction risk. Obtaining source herd, disease and vaccination status information prior to purchase allows for a more educated decision and awareness of how the animals need to be handled once on the operation.(Buhman et al., 2000; Moore, 2006) Conducting pre-purchase exams, diagnostic testing (where applicable) and quarantining animals upon arrival for a period of time are ways to minimize disease introduction for new animals.(Thomson, 1997; Buhman et al., 2000).

Isolation and quarantine

Isolation can be used to keep an infected animal from contacting non-infected animals. Quarantine involves detaining animals suspected of carrying some infectious or contagious disease upon arrival; they may be exposed but not showing clinical signs. While the terms ‘isolation’ and ‘quarantine’ are defined differently, they are often used synonymously. Based on the reported length of time in isolation and testing results, producers may have answered the isolation question with the idea of quarantine in mind. Regardless, the low numbers of herds reporting quarantine (13) or isolation (18) in this study as a disease management tool for newly introduced animals was similar to the findings of other dairy studies. (Rauff et al., 1996; Faust et al., 2001; Dalton et al., 2005; Hoe and Ruegg, 2006; Moore et al., 2009)

The median time in isolation for herds that did not report quarantining newly introduced animals was one week and ranged from seven to 90 days; the latter more indicative of a quarantine time. (Table 7) In the future, studies should define the terms isolation and quarantine as they pertain to the information being collected to provide clarity on these practices for producers.

Reported tests for diseases conducted for animals in isolation in this study were variable but similar to the tests described in other studies.(USDA, 2002; Hoe and Ruegg, 2006; USDA, 2007a; Moore et al., 2009) Diagnostic tests can provide vital health information on which to make educated decisions. Depending on a producer’s risk tolerance, additional information may not affect how the animal is handled on farm. For example, positive test results did not always result in removal of the animal from the herd or placing in quarantine, yet other producers would not have purchased the animal if they would have known the test results prior. (Moore et al., 2009) Developing biological risk management protocols must account for a producer's perception and tolerance of risk. However, animal caretakers and their advisors owe it to consumers to make educated decisions about the health and well-being of dairy cattle introduced to a herd.

Returning animals

Animals that leave and re-enter the herd could also introduce a new disease pathogen to the home herd if precautions such as quarantine and diagnostic testing are not taken. A herd that allows re-entry of animals or has direct contact with other cattle with different vaccination and pathogen acclimation status cannot be considered 'closed'. In the author's experience, this is often a misconception among dairy producers. In this study, two surveys included a comment by the assessor that the herds were 'closed' yet both had animals leave and re-enter, demonstrating the need for more producer education and awareness of how diseases are spread among cattle.

Animal contact

Contact of animals with by-products of other animals (manure, urine, placenta, carcasses) can lead to disease exposure. Rendering trucks may visit multiple operations in a given day picking up animals that may have died from infectious diseases. While regulations exist to minimize spill from the transport vehicle, the possibility still exists for fluids to leak and be deposited on the livestock operation while loading a carcass.(NDA, 2009) Preventing potential contamination from the trucks is a critical control point for disease introduction and only 50% of the operations had the rendering pickup area away from other entrances. This question was not applicable to 21.3% of all operations; producers reported they used on farm composting instead. The question would be more applicable to those operations in the future if reworded to, 'do you prevent the dead/render truck from entering your operation?'

Employees typically have the most animal contact on the operation and some livestock industries (poultry, swine) prohibit employees from handling the same species external to their work environment. The majority of farms (79.7%) did not request their employees avoid livestock contact outside of the dairy. However, details on the type of livestock were not collected. The potential for disease entry exists if precautions like wearing clean clothing and footwear are not taken.(van Schaik et al., 2002; DEFRA, 2003) These protocols overlap with visitor requirements but may be more important for employees given the potential for more on-farm animal contact. One option to control this is for the dairy to provide farm specific clothing and footwear and/or laundry facilities for employees.

Visitors

Dairy operations rely on a variety of support industries for feed delivery, milk collection, equipment maintenance, animal health, and reproductive services where access to common areas on the dairy may occur or animal contact is inherent. The categories for visitors in this study differed from the 2007 NAHMS dairy study but the trend for more visitors per week with increasing herd size was similar. (USDA, 2007b)

Visitors can introduce disease if not managed properly. (van Schaik et al., 2002; Barrington et al., 2002) Management often begins with protocols, yet only 30% of operations described their requirements in any detail. Additional questions in the AQ revealed that only 52% of the operations minimized animal contact with anyone entering and only 27.5% required clean footwear. Contaminated footwear has the potential to spread disease as a fomite on dairy operations yet only five of the large herds (>506 head) and 17 of the small herds (≤505 head) required clean footwear. This trend is similar to the results of the 2007 NAHMS dairy study where more medium-sized herds (100-499 head) implemented disposable or clean boots in animal areas as compared to large herds (>500 head). (USDA, 2007b)

Adult cattle housing

Housing of dairy cattle varies depending on climate and herd size but the principles of minimizing disease spread remain the same in all types of facilities. Clean, dry and comfortable are key husbandry concepts for decreasing exposure to environmental pathogens. Dry cows/pre-fresh animals in this study were primarily housed in dry lots (60%) and lactating cows were primarily housed in free stall barns (66.25%). This differs from the results of the 2007 NAHMS dairy study where 40% of operations housed dry (non-lactating) in dry lots and 63% of lactating cows in tie stall/stanchion barns.(USDA, 2007a) Approximately 47% of the herds in 2007 NAHMS study were <100 head. As herd size increases, housing types trend to more free stalls and dry lots, which could explain the difference since this study only included one small herd (<100 head) by the NAHMS definition.

Maintenance of cattle housing areas is an important part of disease prevention. Areas of stagnant water or organic matter can increase the breeding ground for mosquitoes or flies which can transmit pathogens between cattle. Drier bedding for cattle housing has been associated with lower SCC herds, despite similarities in pathogen concentration. (Hutton et al., 1990) The majority of operations (80% or greater) reported keeping the areas where cows lay or travel clean. (Table 13) For the 65 dairies with stalls, compliance of cleaning was very high (92.3%).Given the large number of dry lot dairies housing lactating and non-lactating cows, 15 operations did not reply to the stall maintenance question. In the future, a more applicable question would be, ‘do you keep the areas where cows lay (stall, dry lot) clean and dry by scraping at least once daily?’

Udder health

Overall, somatic cell count (SCC) was not variable between regions and was similar to findings from the 2007 NAHMS study. (USDA, 2007b) Producers were asked if their SCC was routinely less than 200,000 and there was some discrepancy between their responses and actual SCC numbers reported by data collectors. This was an example of producer-reporting bias. The term ‘routinely’ in the question could have caused producers to answer more generally.

This one closed-ended question, like the other 44, evaluated producer-reported practices but did not verify implementation or judge consistency or quality. Another study that evaluated management style reported that producers who had better overall hygiene and worked precisely rather than fast, described as ‘clean and accurate’, also tended to have a lower herd SCC. (Barkema et al., 1999a) Using actual SCC values as a response variable in this study was appropriate as an initial validation parameter.

Mastitis was one of the primary diseases listed as a concern for dairy operations. Somatic cell count (SCC) is one determinant of milk quality and udder health.(Kehrli and Shuster,

1994) Maintaining SCC below 200,000 cells/mL is more profitable for dairies as compared to those with $\geq$400,000 cells/mL, making it worthwhile to implement cost-effective management practices that reduce SCC.(Ott and Novak, 2001; Wenz et al., 2007) Given the wide variety of topics to be addressed in the 45 questions in this study, a comprehensive review of factors that affect udder health could not be included. However, seven parameters were collected that could directly impact udder health/milk quality including cleanliness of housing (stalls, dry lots, alleys), fly control measures, inspecting animals daily for signs of illness, keeping cows on their feet for 30-45 minutes after milking, and using the California mastitis test (CMT) to monitor cows for mastitis.

In a study by Wenz, et al, producer-reported management practices from the 2002 NAHMS study were evaluated for an association with bulk tank (BT) SCC. Bringing weaned heifers onto an operation was associated with a higher BTSCC. (Wenz et al., 2007) The study reported here found a higher mean SCC in herds introducing lactating animals followed by dry cows, and bred heifers (13-22 months). The number of herds included in both studies is vastly different (1,013 vs. 80) and heifers were only listed as weaned in the Wenz article, which could include two-months old to pre-calving aged animals. Biologically, lactating animals and then dry cows have the greatest probability of affecting herd SCC as they will be immediately added to the bulk tank and monthly DHI testing.

Animal health

The majority of producers reported that they complied with three key practices related to minimizing disease spread on farm – investigation of animals with a change in their eating behavior (95%), promptly euthanizing animals that are not going to recover (93.7%), and inspecting animals daily (90%). Despite these practices, few producers made the decision to separate sick cows from healthy ones (73.8%), so disease spread could still occur.

Veterinarians are often regarded as a key information resource by producers but only 16.3% of dairies utilized their veterinarian's training and skills to necropsy animals that died of undetermined causes. (Faust et al., 2001; USDA, 2007b) Reasons for not using these services were not obtained but the timing of an animal's death does not always allow for convenient post mortem examination and diagnostic sampling. Data were not collected to ascertain how many animals died of an unknown cause; it could be that producers sometimes already knew the reason for an animal’s demise. However, if this was the case, more producers would have skipped the question as it ‘did not apply’ to them. The cause for concern is that if an animal dies for an unknown reason, it may be an indication of something new affecting the herd. New diseases, or new occurrences of diseases, cannot be discovered without investigation. With investigation, it is possible that future occurrences could be prevented.

Disease spread on farm can be minimized through the use of isolation including separate feed, water, equipment, and designated protocols for handling sick animals. There was a large discrepancy between the number of producers that reported separating sick cows and how many actually had a place to put them. Challenges with limited space, not enough labor, shared airspace or equipment may be obstacles to implementing this prevention practice. In a study of Wisconsin dairy producers, housing sick cows with healthy cows was associated with smaller herd size.(Hoe and Ruegg, 2006) Veterinarians and other dairy advisors need to discuss possible solutions with dairy operations who are concerned with this issue.

Feed and water

Diseases can be introduced to dairy cattle through contaminated water and feed. Water troughs can be a source of disease agents, such as *E. coli*, *Salmonella*, and *Listeria monocytogenes*, and 71.3% of dairies reported they cleaned them at least weekly. (LeJeune et al., 2001; Mohammed et al., 2009) A majority (95%) of producers performed some type of visual inspection of feedstuffs.

Manure contamination of feed has been a source of disease so protocols to minimize this are important.(Stabel, 1998; Warnick et al., 2001; Wells et al., 2002) Almost 80% of dairies used different equipment for feed and manure handling, which was much higher than the NAHMS study.(USDA, 2007b) Of the remaining 20% (17 herds), there was no notable difference in herd size and 65% reported cleaning all the manure off the bucket and tires and disinfecting before using for feed. This left six herds that did not prevent cross-contamination of feed with manure, which is a known risk factor for transmitting *Mycobacterium paratuberculosis*, the causative agent of Johnes disease.(Goodger et al., 1996)

Heifer management

Heifers represent the future of a dairy operation. Whether they are raised on the farm of birth or by a custom heifer grower, the basic principles of minimizing disease risk to newborn and growing heifers remains the same. Providing a clean and dry place for calving without exposing them to clinically ill animals, ensuring adequate intake of disease-free colostrum in the first hours of life, and housing them in facilities that protect from the elements and disease exposure to older animals are all manageable disease prevention practices. The first few hours of life are critical to get a calf's immune system off to a good start. Their first exposure to the outside world and all its pathogens is at calving. Space limitations on some facilities often lead to multi-purpose cattle pens. Twenty-five percent of operations in this study did not separate sick animals from calving areas; this did not vary by herd size. (Figure 3) This finding is similar to the 2007 NAHMS study that reported 26.2% of medium and large herds share the usual calving area.(USDA, 2007a) By housing sick animals in maternity pens, the probability of disease exposure to newborn calves increases. (Naugle et al., 2004) This is one critical control point for breaking disease transmission on farm, especially for orally contracted pathogens, such as *Mycobacterium avium* subsp. *paratuberculosis* (Johne's disease) and *Salmonella*.

Separating calves at birth prior to nursing with subsequent feeding of good quality, disease free colostrum are two practices that have been recommended to increase the calf's resistance to disease and decrease exposure to and subsequent shedding of pathogens.(Brignole and Stott, 1980; Quigley et al., 1994; BAMN, 1995) Overall, more dairy operations (71.3%) in this study complied with removing calves at birth prior to nursing compared to herds (55.9%) in the 2007 NAHMS dairy study.(USDA, 2007a)

Only 36.3% of herds collected colostrum within 2 hours of calving but nearly 74% of herds fed colostrum by six hours of age. In a Pennsylvania study, 43.6% of farms fed calves within 2 hours of birth while the 2007 NAHMS study reported calves were fed colostrum, on average, 3.3 hours after birth, similar to results presented here. (Kehoe et al., 2007; USDA, 2007a) Studies have looked at volume of colostrum delivered within the first 24 hours of life, and producers in this study reported a higher compliance of calves receiving a second dose compared to feeding in the first six hours. Thirty-five herds (43.7%) in this study pooled colostrum from multiple cows which was over twice as high (21.0%) as the 2007 NAHMS study. (USDA, 2007a) The trend was similar to the NAHMS study where large herds (>506 head) were more than twice as likely to pool colostrum as compared to smaller (≤505 head) herds.

Numerous studies have looked at the health benefits of pasteurizing waste, or non-saleable milk prior to feeding to calves.(Butler et al., 2000; Stabel, 2001; Stabel, 2008) In this study, 38.8% did not answer but stated they fed milk replacer or did not raise pre-weaned calves on farm. Of the remaining 49 herds, only 34.7% reported pasteurizing waste milk, most of which were large herds. For a known critical control point for diseases such as Johne's and *Mycoplasma* spp. infections, adoption of pasteurization is lagging in this population of farms. Reasons were not collected, but this is often dependent upon the number of calves on milk at a given time, personnel and facilities available to manage and store the system, and the initial investment cost. (BAMN, 2008; BAMN, 2009) Pre-weaned calves (21.3%) in this study were most often raised off farm; more often those from California dairies and large herds (>506 head). In contrast, the 2007 NAHMS dairy study reported the percentage of calves raised off farm increased as herd size increased, for all phases.(USDA, 2007a) Reasons for raising heifers off site were not collected in this study but this is often a factor of available labor on the dairy, facilities, feedstuffs, land base and financial investment.

Housing demographics were obtained for calves on the 80 dairies. Pre-weaned calves are particularly susceptible to disease and individual housing without direct contact to other calves or older animals decreases the opportunity for disease spread. (Quigley et al., 1994; Barrington et al., 2002) Of the 63 herds that raised heifers on the same farm as lactating animals, 68.2% were raised individually in hutches; 20.6% were raised in pens with either solid or mesh panels separating the calves. To break the cycle of fecal-oral disease spread, control points should be implemented to minimize calves and young stock exposure to manure from other animals.(Stabel, 1998; Barrington et al., 2002; Naugle et al., 2004) Thirty percent of dairies reported they did not prevent young animals from coming in contact with manure from older animals.

Risk perception

Dairy operations in this study varied in herd size, milk production, milk quality, housing, calf management, etc. The disease challenges, either perceived or real, also varied among the producers. In a study by Faust et al, herds introducing animals treated or culled a larger proportion of animals due to BVD, papillomatous digital dermatitis, Johne’s, salmonella, and mastitis. (Faust et al., 2001) Producers’ perceptions of disease risk could be based on previous experience, the media or their community.(Slovic, 1987) Personal experiences or discussion of outbreaks in the dairy industry could influence a producer’s perception of risk and the diseases of which they are most concerned. When producers were asked about what diseases they test for while in isolation, BVD, Johne’s and *Staph aureus* were included. This overlapped with some of their concerns and perceived risks indicating that some producers are attempting to manage these diseases through testing.

Conclusions

The objective of this chapter was to report the current biological risk management practices of California and Midwest dairies of different sizes and management styles. Vulnerabilities were identified with respect to new or returning animal introductions, lack of isolation or quarantine facilities, absence of protocols for visitors or employees with animal contact, lack of a necropsy for animals dying of unknown cause, and not minimizing young stock exposure to manure.

New or returning animals pose the largest disease entry risk on dairies. A majority of producers perceived mastitis as a primary disease challenge for their operation. Analysis showed that 70% of the herds introduced animals, and their herd average somatic cell count was well over the industry goal of 200,000. The highest somatic cell counts were in the herds that introduced lactating and dry cows. If this is truly a concern, producers should put prevention practices in place that can decrease the risk of disease entry.

Isolation facilities and quarantine procedures can help limit disease entry to a dairy, yet these were lacking for the majority of herds. This seems to be a universal challenge on U.S. dairy operations. Testing for key diseases was also lacking. Screening tests exist for a variety of mastitis causes and could be better utilized as a tool for dairies to minimize disease entry, along with quarantine protocols. Future studies should investigate the barriers faced by producers to implement these critical steps.

Other areas for improvement across dairies related to managing fomites – employees and visitor protocols for animal contact, wearing clean clothes/footwear, and taking precautions when moving between animals of different age groups. The financial investment for these practices is minimal and each could decrease the infectious burden on farms and to susceptible animal groups.

This study suggested that producers monitored health daily and investigated animals that do not eat. However, few producers followed up with post-mortem investigations on animals that died for unknown reasons. This is a critical step to diagnose unusual, possibly new diseases utilizing the knowledge and skills of veterinarians. This study did not collect reasons for the lack of post-mortems, but uncovering dairy producer's perception of this practice could be accomplished through future surveys.

Producers also expressed concern with Johne's disease on their operations. The most susceptible animal on a dairy is the young calf and protocols aimed at minimizing manure exposure could break the cycle of disease spread. Critical control points such as cleaning and disinfecting footwear or changing out of contaminated clothes prior to handling were reported on less than 20% of operations. Dairy producers may be missing an opportunity to prevent disease spread between calves.

The overall objective of this project was to identify disease prevention practices that correlated with positive outcomes on dairy operations. As an initial validation of a newly developed assessment tool, obtaining producer-reported prevention practices was a logical first step. Future studies could use a refined tool with more precise questions and actually verify implementation of, or barriers to implementing, the various prevention practices.

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Chapter 4. Biological risk management (BRM) practices associated with milk production and quality

Introduction

There are an abundance of recommendations aimed at keeping disease out of dairy operations or preventing their spread. Dairy producers have a multitude of options to choose from if they know what vulnerabilities exist on their operation. To help producers identify and manage disease challenges, biological risk management tools were developed to assess risk management practices on dairy operations, as discussed in chapter two. Each management practice was based on one or multiple routes of disease transmission (aerosol, direct contact, fomite, oral, vector and zoonotic). Disease exposure can be minimized by implementing management practices for the various routes of transmission.

Implementing critical control points can take time and money. Knowing which recommendations positively impact animal health and production parameters could aid in the decision making process and help dairy producers set priorities. The objective of this study was to identify specific management practices that positively correlated with milk production (305 day mature equivalent) or quality (somatic cell count).

Methods

Selection of dairy herds

Extension personnel in California and Iowa asked dairy producers that milked at least 100 cows and utilized a Dairy Herd Improvement (DHI) record service to participate in an on-farm assessment of biological risk management (BRM) practices. Dairy operation participants represented a convenience sample, meaning they met the study requirements and were willing to participate when asked by the data collectors. Data collectors made an appointment and interviewed the dairy producer on-farm by asking each question in a two-part questionnaire. Participants did not receive payment. The data collectors were provided with a series of three reports which summarized the questionnaire results to return to the dairy producers.

Questionnaire design

Two questionnaires were utilized in this study. A three-page Pre-Assessment Questionnaire (PAQ) consisting of 14 open-ended questions regarding herd demographics, production parameters, animal introduction, visitor protocols, and isolation facilities. A copy of the Dairy Herd Improvement (DHI) herd summary sheet (containing the previous 12-months test results) was requested to accompany the PAQ production information.

A three-page Assessment Questionnaire (AQ) consisting of 45 closed-ended questions with response choices of ‘yes’, ‘no’, or ‘maybe’ was also utilized to collect information about animal contact, visitor/employee protocols, hygiene, milking procedures, colostrum and calf management, and feed and manure handling. The full questionnaires are available in Appendices 7 and 8. The questions were peer-reviewed and pre-tested by third party data collectors to ensure content was appropriate and questions could be interpreted properly.

Data processing and analysis

The de-identified assessment questionnaires were sent to one technician either in California or Iowa for entry into an online database. Reports were generated for the data collectors to deliver back to the dairy producer. All data from the PAQ, AQ and herd summary sheets (if available) were entered into a spreadsheet program (Microsoft Excel™, 2003). The spreadsheet data for the AQ were compared to results from the online BRM database and those entered by the technician in California to ensure congruency. This step was important to prevent loss of data or errors during the transfer process. Responses for each question in the AQ were recoded into categorical (nominal) data such that ‘yes’ responses became a one and ‘no’ and ‘maybe’ responses became a zero. From a disease management standpoint, ‘maybe’ responses indicated the practice was not always implemented, thus the chance of disease entry or spread still existed. These responses were treated as ‘no’ in the final analysis. The data were then exported for further analysis into JMP® 7.0.2 (SAS Institute Inc., Cary, NC).

Frequency distributions of responses were evaluated for all questions and those with non-informative responses were removed (question response rate for all farms of $\geq$90% yes or $\geq$90% no/maybe or $\geq$5% not applicable (N/A)), referred to as the 90% agreement level. Responses to the PAQ that provided more information for the AQ were combined into new indices (independent variables). Additional methods to reduce multicollinearity included removing non-informative variables and screening for correlations between independent variables using Spearman's rank correlation coefficient; values >0.75 were considered correlated (JMP® 7.0.2, SAS Institute Inc., Cary, NC). As an exploratory analysis, hierarchical cluster analysis was performed using the Ward algorithm in JMP® 7.0.2. Questions with similar responses (yes or no) were grouped (clustered) based on how homogeneous they were across all dairies. Questions with similar responses were paired and had small numerical distance measurements between them.

Two dependent variables were evaluated in this study. Milk production was represented by 305 day mature equivalent (305d ME High) as a categorical variable and milk quality was represented by somatic cell count (SCC), a continuous variable. The relationship between disease prevention practices and SCC or 305d ME High was evaluated using student's *t*-test for continuous measurements and chi-square or Fisher's exact test for proportions. Each independent variable was critically evaluated for biologic plausibility with the dependent variable.

The relationship between 305d ME High or SCC and informative prevention practice were modeled. Logistic regression and generalized linear models were constructed using a combination of forward and backward stepwise elimination using JMP® 7.0.2. Variables with p-values <0.10 were included in the model. The variables days in milk, total cows, milking frequency, region (California or Midwest) and use of bovine somatotropin (bST) were evaluated in the final model to examine their role as confounders and effect modifiers. The final model retained factors significant at $p<0.05$.

Results

Response

On-farm assessments were conducted on 40 California and 40 Midwest dairies from February-June 2006 and February-June 2007, respectively. Assessments were conducted by six University of California, Davis dairy farm advisors in the Central Valley (primary area of California's dairy population) and six Iowa State University extension faculty in 24 Midwest counties. On-farm interviews lasted 30-45 minutes. Four operations were excluded (three

California due to no reported use of DHI; one Midwest due to herd size [92 head]). The remaining 76 were included in the analysis. A copy of the DHI herd summary sheet was provided by 38 herds.

Data processing

Question response frequency was evaluated and six assessment questions were excluded at the 90% agreement level (either all 'yes' or all 'no/maybe'). Select data from the PAQ were combined with the AQ to create one additional informative index, 'do you have a closed herd, not introducing any new animals'. Six questions with four or more 'not applicable' responses (did not apply to 5% or more operations) were excluded. Thirty-four questions remained in the analysis. Thirty and 24 questions remained for the 85% and 80% agreement level, respectively. There were no significant correlations among the 34 questions.

Cluster analysis was performed on the 34 questions. Based on the similarities in response patterns across the 76 dairies, three clusters were identified. Six paired questions were very similar in their response patterns based on their distance relationship. (Table 1)

Table 1. Paired questions based on similar responses (yes or no) across 76 dairies by cluster with distance measurement (no scaling).

Question pair	Cluster	Distance
AlleyCl and CleanH2O	1	4.885
TxRecord and DailyIll	1	4.955
CleanClo and CleanFt	3	5.392
NoNurse and 1GalCol	1	5.840
FeedSepar and HeifKnow	1	5.866
Park and BootC&D	3	6.244

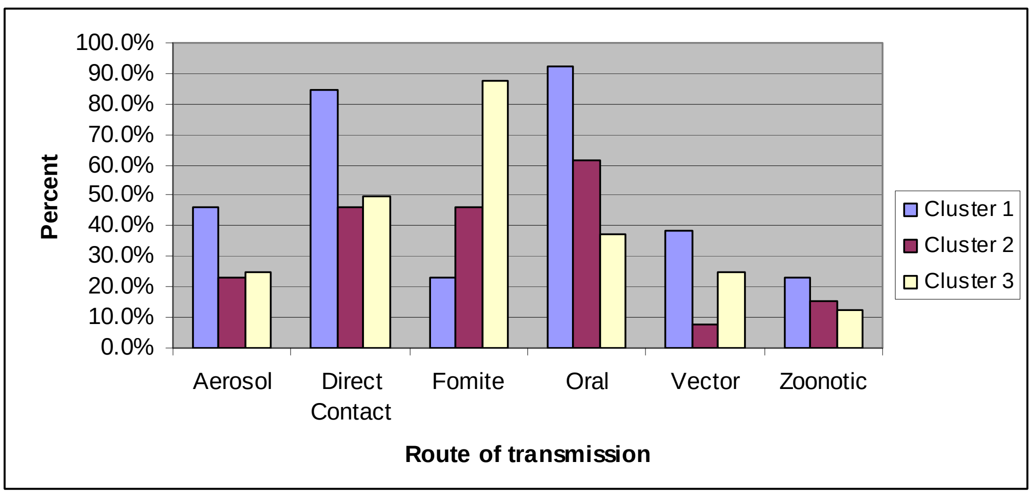
[AlleyCl] Do you keep your alleys clean (scraped or flushed at least one time daily)? AND [CleanH2O] Do you clean water troughs/cups frequently (at least weekly)?
[TxRecord] Do you keep treatment records for all animals? AND [DailyIll] Are all animals inspected daily for signs of illness?
[CleanClo] Do you require clean clothes on everyone entering your operation (visitors, service personnel)? AND [CleanFt] Do you require clean footwear on everyone entering your operation (visitors, service personnel)?
[NoNurse] Do you remove calves from mothers at birth, not allowing them to nurse? AND [1GalCol] Do you give newborns ¾ to 1 gallon of colostrum within the first 6 hours of life?
[FeedSepar] Do you use different equipment for feed and manure handling? AND [HeifKnow] Is the origin of all replacement heifers known?
[Park]Do you have a designated visitor and employee vehicle parking area? AND [BootC&D] Are employees required to clean and disinfect their boots when moving into special areas of the farm such as the maternity and calf areas?

Within each cluster, prevention practices were evaluated by farm level (disease entry, spread or calf disease management) and animal level (aerosol, direct contact, fomite, oral, vector and zoonotic) exposures. Specific zoonotic exposure questions were not selected but the category remained due to single prevention practices containing multiple categories. See Table 2 and Figure 1 for results.

Table 2. Percent of farm level prevention practices in each cluster of the informative 34 questions utilized in the study of 76 dairy operations.

34 Assessment Questions			
Farm level	**Cluster 1 (n=13)**	**Cluster 2 (n=13)**	**Cluster 3 (n=8)**
Disease entry	15.3%	23.1%	62.5%
Disease spread	53.9%	53.8%	37.5%
Calf disease mgt	30.8%	23.1%	0%

Figure 1. Percent of animal level (route of disease transmission) prevention practices in each cluster of the informative 34 questions utilized in the study of 76 dairy operations. Single questions could contain multiple route categories.



Dependent variables

A minimum of five different DHI testing centers represented the 76 herds in the study. Calculations for the production parameter, 305 day mature equivalent (305ME) varied among these locations as to whether or not they accounted for breed differences. Therefore, a direct comparison across the herds using this variable as reported could not be done. Each operation's 305d ME was compared to the breed average 305d ME from a national database (DairyMetrics 2007, Dairy Record Management System). Study herds with 305d ME greater than breed average plus one standard deviation were manually assigned to the high producing group. Herds below the ‘breed established’ cut-off were assigned to the low producing group. This resulted in 26 high and 50 low producing herds. Student’s *t*-test (high compared to low) revealed a difference in the means of 305d ME of 3,493.7 pounds ($p<0.0001$, data not shown).

Two types of models were evaluated based on the response variables. No treatment was applied to the response variable, somatic cell count (SCC); it was normally distributed and treated as continuous in all models. The response variable, 305d ME High, was treated as a categorical variable in all models.

Descriptive results

Herd size ranged from 108 to 3,550 head (average 770). There were 60 Holstein herds, seven Jersey herds, one Guernsey herd and eight mixed herds. Mixed herds are those with less than 75% of the herd consisting of the same breed. This could consist of 70% pure Holstein and 30% pure Jersey, or an entire herd of cross-bred animals. (Greg Palas, personal communication) Herd demographic data are presented in Table 3.

Table 3. Herd demographic information for 76 dairy operations and by region.

Variable	**All Herds (n=76) median (range)**	**California (n=37) median (range)**	**Midwest (n=39) median (range)**
Herd size	499.5 (108-3550)	810 (145-3550)	296 (108-2985)
Somatic cell count (SCC) x 1,000	258 (110-954)	250 (110-474)	297 (124-954)
305 day mature equivalent (ME) (lbs)	24,236 (15,564-30,586)	24,000 (15,564-30,586)	24,334 (17,375-29,276)
High producing herds	34.2%	27.0%	41.0%
Bovine somatotropin (bST) use in herd	52.6%	37.8%	66.7%

Chapter 3 reported no difference in 305d ME production (continuous variable) between herds that used bST and herds that did not. This analysis was repeated using a chi-square test with the new categorical variable, 305d ME High. There was no statistical difference ($p=0.2621$) between high producing herds using bST and high producing herds without bST.

Univariate results

Out of a possible 33 prevention practices, student's *t*-test revealed three that corresponded to decreasing SCC and two that increased SCC at p<0.10. The question, 'is your somatic cell count routinely under 200,000', was not included in the analysis due to redundancy with the response. (Table 4)

Table 4. Select disease prevention practices (included if p<0.10) resulting in a difference in the means of somatic cell count (SCC) for the dairies that performed the prevention practice (yes) as compared to those who did not (no/maybe).

	Student's *t*-tests	
Prevention practice	**Difference in SCC means, if 'yes'**	**p value**
Do you remove calves from mothers at birth, not allowing them to nurse? [NoNurse]	-65,786	0.04
Do you have a fly control program? [Fly]	-75,812	0.04
Do you have a closed herd, not introducing any new animals? [IntrodAns]	-50,368	0.09
During chores, do you move from "clean" younger animals to "older" animals, to "dirty"/sick animals, and finally isolation animals? [ChoreOrd]	72,162	0.02
Do you clean water troughs/cups frequently (at least weekly)? [CleanH2O]	58,307	0.07

Out of a possible 34 prevention practices, chi-square tests revealed two that corresponded to high production (305ME high) at p<0.05. (Table 5).

Table 5. Select disease prevention practices associated with 305 day mature equivalent high (305d ME High) production for the 76 dairies that performed the prevention practice (yes) compared to those who did not (no/maybe). The table only includes the significant prevention practices at p<0.05.

Prevention practice	**Odds Ratio (95% CI)**
Is your somatic cell count routinely under 200,000? [SCC<200]	3.34 (1.15 – 9.65)
Do you have a closed herd, not introducing any new animals? [IntrodAns]	2.72 (1.02 – 7.25)

Modeling

In the final generalized linear model, six prevention practices, region (California or Midwest) and use of bovine somatotropin (bST) were associated with SCC. (Table 6)

Table 6. Full model results (<0.0001) associated with a change in milk quality (SCC) as the main effect variable, that performed the six prevention practices (yes = 1), Region (California = 1) and bST use (yes = 1). Intercept (SCC) = 328,458.

Explanatory variables (Prevention practice)	**Main Effect Parameter Estimate, if Yes**	**p value**
NoNurse [1]	-47,511	0.0002*
CleanH2O [1]	46,093	0.0011*
Region [1]	-33,581	0.0046*
ChoreOrd [1]	31,193	0.0059*
½GalCol [1]	-34,356	0.0080*
Fly [1]	-36,875	0.0091*
Colost2h [1]	-28,964	0.0138*
bST [1]	25,553	0.0263*

*Significant at $p<0.05$

[NoNurse] Do you remove calves from mothers at birth, no allowing them to nurse?
[CleanH2O] Do you clean water troughs/cups frequently (at least weekly)?
[ChoreOrd] During chores, do you move from “clean” younger animals to “older” animals, to “dirty”/sick animals, and finally isolation animals?
[½GalCol] Do you give a second dose (½ to ¾ gallon) of colostrum 12 hours later?
[Fly] Do you have a fly control program?
[Colost2h] Do you collect colostrum within the first 2 hours after calving?

Generalized linear model equation for the milk quality (SCC) full model:

SCC = 328,458 + (-47,511*NoNurse) + (46,093*CleanH2O) + (-33,581*Region) + (31,193*ChoreOrd) + (-34,356*1/2GalCol) + (-36,875*Fly) + (-28,964*Colost2h) + (25,553*bST)

A combination of backward and forward stepwise elimination procedures were used to create the final logistic regression model with five prevention practices, use of bST, and their association with the production parameter, 305d ME High. (Table 7) The odds of having high milk production were lower for dairies that cleaned their waterers at least weekly. The odds of having higher milk production were 6.40 times greater for operations reporting SCC less than 200,000 cells/mL compared to herds with SCC greater than 200,000. The odds of having higher milk production were 6.37 times greater for dairies that used bST compared to those who did not. The odds of having higher milk production were 31.36 times greater for operations inspecting animals daily for signs of illness. The odds of having higher milk production were 12.97 times greater for dairies that cleaned their alleys at least daily. Finally, operations that prevented young animals from contacting manure of older animals were 4.36 times more likely to have higher milk production than those that did not.

Table 7. Full logistic regression model results ($p=0.0005$) describing the association between five prevention practices and bovine somatotropin (bST) use (yes = 1) and high milk production (305d ME High).

Explanatory variables (Prevention practice)	**Odds Ratio, if Yes**	**95% Conf. Interval**	**Full model p value**
CleanH2O [1]	0.02	0.00 to 0.21	0.0030*
SCC<200 [1]	6.40	1.66 to 30.14	0.0106*
bST [1]	6.37	1.62 to 32.93	0.0142*
DailyIll [1]	31.36	2.38 to 1211.72	0.0249*
AlleyCl [1]	12.97	1.35 to 202.11	0.0416*
NoYoungOld [1]	4.36	1.16 to 20.73	0.0421*

*Significant at $p<0.05$

[CleanH2O] Do you clean water troughs/cups frequently (at least weekly)?
[SCC<200] Is your somatic cell count routinely under 200,000?
[DailyIll] Are all animals inspected daily for signs of illness?
[AlleyCl] Do you keep your alleys clean (scraped or flushed at least one time daily)?
[NoYoungOld] Do you prevent young animals from coming in contact with manure from older animals?

Logistic regression equation for the milk production (305d ME high) full model:

$$\text{logit}(p) = -2.272 + (-1.855*\text{CleanH2O}) + (0.928*\text{SCC}<200) + (0.926*\text{bST}) + (1.723*\text{DailyIll}) + (1.281*\text{AlleyCl}) + (0.736*\text{NoYoungOld})$$

Discussion

The goal of cluster analysis was to determine if similar types of questions were grouped together based on similar response patterns across all 76 dairies. Some of the paired questions had a biologically plausible relationship. For instance, cleaning alleys and cleaning water troughs are both cleaning tasks in the cattle housing area aimed at reducing pathogen exposure at the animal level. Keeping treatment records and inspecting animals daily for illness are both related to monitoring and tracking health status of the animals. Requiring clean clothes and footwear on farm coincide as practices to limit pathogen introduction at the farm level. The practices of removing the calf at birth and administering colostrum within six hours naturally correspond with one another.

The farm level prevention practices, aimed at identifying disease entry, disease spread or calf disease management, were split similarly in clusters one and two. The third cluster did not contain any calf disease management questions. The animal level prevention practices, using the routes of disease transmission, had representation in all clusters. Oral (92.3%) and direct contact (84.6%) transmission were the primary routes in cluster one; both are involved in disease spread. Oral (61.5%) transmission was also the primary route in cluster two, followed by direct contact and fomite (46.2% each); all three are involved in disease spread. Cluster three contained the highest percentage of fomite (87.5%) related prevention practices and fomites can introduce disease onto an operation.

Combining this information, disease spread on farm, especially to calves, often involves oral and direct contact exposures. Notable prevention practices in cluster one included using separate equipment for feed and manure handling, cleaning alleys and waterers, preventing manure contact between young and old animals, using separate pens for sick animals and calving, and removing calves at birth prior to nursing.

Some exposures require a fomite as the carrier of the pathogen, explaining the close relationship in cluster two between direct contact and fomites. Questions in cluster two demonstrating this relationship included limiting exposure of employees with livestock outside of the operation, not feeding leftover feed to youngstock, separating sick animals, pen entry that did not require stepping in the feedbunk, and performing chores in order from young to old, sick, and isolation last.

Cluster three primarily consisted of disease entry prevention practices. Many of the questions were fomite related, specific to visitors, such as designated parking areas, requiring clean footwear and clothing, and posting signs restricting access to the operation. The practice of not introducing animals was also in this cluster.

In the univariate analysis, three prevention practices were associated with a lower somatic cell count (SCC) including removing calves at birth prior to nursing, having a fly control program and not introducing any animals. These practices make biological sense in that after calving, during manual or machine removal of colostrum, the producer has a greater likelihood of identifying udder health abnormalities and subsequently controlling SCC through therapy and/or continued monitoring. Machine removal of colostrum can be more complete and sanitary than allowing a calf to suckle. Flies are known vectors of disease agents that can cause mastitis, so having a control program could lower SCC.(Gillespie et al.,

1999) In a study by Faust et al., 18.8% of herds during an expansion indicated higher treatment or removal of cows due to mastitis.(Faust et al., 2001) Herds in the current study that did not introduce animals had lower SCC.

There were two prevention practices that increased SCC: frequently cleaning water troughs/cups and performing chores from the youngest to the oldest, with sick and isolation last. It could be proposed that by frequently cleaning waterers, more moisture is generated in the cattle housing or traffic area. Increased moisture content of bedding is associated with more environmental mastitis pathogens leading to increased mastitis.(Hutton et al., 1990) Details related to the type of waterer, the location within the facility, method of cleaning, etc was not collected. There may have been circumstances on farm, unmeasured by this study that could explain the inverse relationship between the prevention practice and SCC. It could also be a spurious finding.

The practice related to chore order could be due to producers answering ‘no’ because they had dedicated people taking care of the younger animals as opposed to the older animals. In that regard, the disease risk of transmitting pathogens between groups of animals was managed and exposure minimized through an unmeasured practice. The question as written could not capture that information, but could explain why a ‘no’ response led to decreased SCC. Another possibility is that producers who said ‘yes’ were more likely to have sick animals in the herd. Producers who reported ‘no’ may not have had any sick animals, thus having a lowered SCC as compared to herds requiring the handling of sick and isolation animals. Previous results from this study (Chapter 3) reported that isolation facilities were not available on the majority (77.5%) of operations. This could have affected producer response and subsequent results of the association with SCC.

The odds of a dairy operation being classified as high producing (305d ME High) was 3.34 times higher when their SCC was less than 200,000 cells/mL and 2.72 higher when they did not introduce animals. Both of these relationships, SCC and animal introductions, with milk production are complex issues. However, previous studies have also shown a relationship with lower SCC and increased milk yield. (Dohoo et al., 1984; Bartlett et al., 1990; Wilson et al., 1997; Ott and Novak, 2001) Cows with healthy udders tend to produce more milk. Newly introduced animals, particularly adult cattle, have been a source of disease introduction to dairy herds.(Losinger and Heinrichs, 1996; Vaessen, 1998; Faust et al., 2001; van Schaik et al., 2002; Nielsen et al., 2007) A variety of disease conditions, such as *Salmonella*, bovine viral diarrhea, Johne's, can result in lower milk production.

These independent prevention practices should be considered as potential critical control points on dairy operations who aim for higher than breed average milk production and lower somatic cell counts. However, animal health and production are complex systems relying on a variety of factors. Performing one practice without consideration for others may not provide the desired results. Therefore, the interactions of these prevention practices with production and milk quality were evaluated through models.

Modeling prevention practices

The results of the generalized linear model demonstrated dairy operations in the Midwest and herds that used bST were associated with higher somatic cell count (SCC). These findings agree with the descriptive results. Days in milk and milking frequency had no effect on the SCC and were not retained in the final model.

To interpret the equation for the full model of SCC, dairies that said 'no' to having a fly control program would increase SCC by 36,875 as compared to other study herds without a fly control program with everything else constant (located in region 1 – California, using bST and answering yes to the five other questions). The prevention practice, cleaning waterers at least weekly, had an unexpected effect on the outcome SCC. As a result of the model, dairies that said 'no' to cleaning waterers weekly decreased their SCC by 46,093 as compared to other study herds that cleaned their waterers at least weekly, all else being constant as previously described.

Overall four disease prevention practices decreased SCC including removing calves at birth prior to nursing, collecting colostrum within two hours of calving, giving a second dose (1/2 to ¾ gallon) of colostrum 12 hours after the first feeding, and having a fly control program. Controlling fly numbers on farm decreases the likelihood of spreading disease agents that can cause mastitis and subsequent higher SCC.

The other three practices related to the time around calving where attention to detail is necessary to closely monitor and promptly remove calves at birth. If timing of birth is known, the same dairy operation is more likely to collect colostrum within the first two hours. Administering a second dose of colostrum to calves also relies on this timing and requires attention to detail. With increased monitoring of the cow and calf around calving, it could be proposed that this attention to detail carries over to examining the udder for mastitis. Changes in the udder or mammary secretions caught early, while milk is still being withheld from commercial sale, allows for management decisions (treatment, continued monitoring) that could ultimately lower that cow's SCC and contribution to herd SCC in early lactation. The same two prevention practices that increased SCC in the univariate analysis were significantly associated with increased SCC in the final model (cleaning waterers weekly, chore order).

The results of the nominal logistic model demonstrated dairy operations that used bST were associated with a higher 305d ME when combined with the five explanatory variables. The effect of bST on milk production has been described in other studies. (Bauman et al., 1999; Collier et al., 2001) When bST is combined with other prevention practices, it demonstrates association with 305d ME High. Days in milk and milking frequency had no effect on 305d ME High and were not retained in the final model.

The four disease prevention practices that were associated with dairies being in the High 305d ME category included having a SCC less than 200,000, inspecting animals daily for illness, keeping alleys clean and preventing young animals from contacting manure from older animals. As previously discussed, low SCC is related to higher milk production. Daily inspection of animals allows early recognition of changes in animal health and subsequent management decisions (treat, increase monitoring, separate from pen mates) to be implemented. This attention to detail may prevent disease spread. As previously discussed, diseased animals have decreased milk production. It should be noted that 89% of the operations in this study performed this practice, which explains the high odds ratio and wide confidence interval. Cleanliness as it pertains to manure management in animal traffic areas or to young calves are critical control points for decreasing the risk of oral exposure. By decreasing infectious burden in the environment, animals immune systems are not as challenged, leaving energy for the body to produce more milk. The high odds ratio and wide confidence interval for cleaning alleys daily may have been influenced by 86.5% of the farms reporting they performed this practice.

The prevention practice, cleaning waterers frequently, was negatively associated with milk production in the final model. While there were no significant pairwise correlations, CleanH2O and AlleyCl clustered together based on their responses across all dairies in the data set. From a management standpoint, waterers are often located in animal traffic areas (alleys). The relationship between these two practices cannot be ignored, and when included together in the model, the effect of cleaning waterers on milk production was decreased by cleaning alleys.

The method of cleaning or type of waterer was not collected in the assessment. It can be assumed that most of the herds in this study contained trough type waterers as opposed to cups based on housing type (described in Chapter 3). The sediment in trough type waterers often contains bacteria (coliforms, *E. coli*) and protozoa. (LeJeune et al., 2001) In order to remove sediment from troughs, the water supply must be shut off, the tank allowed to drain while manually pushing/scooping the sediment out. To remove the rest of the organic matter, the trough must be scrubbed followed by a final rinse before capping the trough to refill. Without assessing the method used to clean in this study, saying 'yes' to the action of the cleaning may have resulted in the sediment being agitated, rather than removed, thus distributing pathogens equally throughout the waterer. This in turn could increase the infectious burden in the water supply of disease organisms, frequently exposing animals and resulting in decreased milk production due to the challenge on the cow's immune system.

Limitations of this study design were discussed in Chapter 3.

Conclusions

Three clusters represented the 34 disease prevention practices and there was a relationship between farm level and animal level exposures. Two clusters had primarily disease spread questions and were represented by the corresponding routes: oral and direct contact with fomites. The third cluster primarily consisted of disease entry questions represented by the fomite route of transmission. These associations validated the new approach of focusing on disease prevention practices by the routes of disease transmission. From a disease exposure standpoint, critical control points for each route of transmission should naturally group together.

The overall purpose of this study was to identify which practices were positively associated with higher milk production (305d ME) and lower SCC. Introducing animals to a herd did not prove significant as an effect of all variables in the final model, but it remains a critical control point as an independent prevention practice for both milk production and quality.

Prevention practices that correlated with higher milk production and lower somatic cell count included management styles characterized as ‘attention to detail’. For instance, fly control, having a SCC less than 200,000 cells/mL, inspecting animals daily, cleaning alleyways, and preventing young animals from contacting manure from older animals. Practices aimed at minimizing disease exposure to calves included prompt removal at birth, obtaining colostrum within two hours, second colostrum feeding, and preventing exposure to manure pathogens positively affected milk production and quality on a herd level. These practices may require more time but if the dairy producer’s priority is higher milk production and lower somatic cell count, the investment could pay for itself.

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Chapter 5. Lessons learned from the initial validation of the dairy BRM toolbox with recommended modifications

Lessons learned

There are a myriad of recommendations available to producers to help minimize disease entry and spread on a dairy operation. Disease challenges will continue to plague dairy cattle. It is the caretaker's responsibility to minimize that threat while continuing to supply a safe food supply. Providing a tool to identify and reduce the vulnerabilities to disease entry and spread on livestock operations was the reason behind developing the dairy biological risk management (BRM) materials. An extensive review of recommendations was involved in its creation. The outcome was a set of peer-reviewed resources available online, free of charge, for dairy producers and their advisors to utilize.

Validating biological risk management practices on dairy operations was a challenging endeavor. A broad range of topics were addressed in this initial study to ascertain producer-reported prevention practices on a variety of U.S. dairy operations. Specific disease entities were not the focus. Changes in animal health status were not the measured outcome. Rather the goal was to identify which prevention practices aimed at controlling disease entry and spread through five main routes of transmission had a positive effect on production parameters. It was a novel approach to evaluating management practices, with limitations and valuable lessons learned for future projects.

Novel approach

This was the first study to utilize a risk analysis approach on individual dairy operations. Disease risk perception data were obtained in this convenience sample of 80 U.S. dairy operations. Risk management assessments collected quantitative data on milk production, milk quality, and herd demographic information, as well as producer-reported disease control practices. Risk management recommendations were provided based on the vulnerabilities identified for disease entry or spread. Finally, risk communication tools were provided to producers based on their perceived disease concerns and identified vulnerabilities.

The content used to develop the questionnaires and recommendations were based on published information wherever possible. In some areas, there was little science and previously validated references. Therefore, peer-review by experienced dairy veterinarians and farm advisors was relied upon as the best approach.

Anecdotally, feedback received from assessors indicated the goal of increasing awareness of disease prevention practices on farm was achieved. Discussions with the assessors during the interview and follow-up visit to present the results were positive and well-accepted by the producers. While there may be limitations in the validation of the recommendations, as discussed next, the risk management assessments themselves provide an educational tool and a way for advisors to learn more about the dairy operations they serve.

Study limitations

There were more than 11 assessors/data collectors for this study ranging from new farm advisors and students to experienced farm advisors and dairy field specialists. Given the different geographic regions included, this was an economical approach to gather information. Additionally, many of the assessors were familiar with the dairy producers in their area and could identify willing participants. Some had a personal relationship, one of a trusted advisor, and dairy producers may have participated because of this. Some producers may be more honest with trusted advisors; people who have helped them evaluate and overcome challenges in the past. The opposite could also be true. Producers may want to please someone with whom they have a relationship and answer positively regardless of actual implementation. Actual implementation of practices may or may not have been observed, making the results subject to reporting bias.

The assessors knowledge of and personal relationship with dairy producers may have contributed to exceeding the original goal of 30 dairies in the first year of the study. This also introduced the potential for interview bias. Interviewers were educated about the concepts of biological risk management and provided with recommendations on how to conduct the on-farm assessment to try and minimize this bias. The overall impact of interviewer bias on the final results was hard to measure. However, this bias was accepted given this was an initial study using a new tool and knowing that the assessments were designed to be administered by dairy advisors. Future studies should consider limiting the number of assessors, one would be ideal, to further limit the effects of interviewer bias.

The assessors were responsible for identifying willing participants that met the study criteria, resulting in a convenience sample. This was not representative of all U.S. dairies and results should be extrapolated with caution. Trends identified for dairies in this study were similar to other randomized studies, so the information should not be completely disregarded either. Randomized selection of farms would have made the results more externally applicable and should be considered in future studies using the risk management assessment.

Selecting the outcomes of measurement for this study was based on readily available information utilized by all dairy operations. Dairies had to participate in Dairy Herd Improvement (DHI) testing to be eligible. The selection process was driven by the need to give dairy producers an outcome they could all relate to and something used as a benchmark to compare themselves to other dairies. Somatic cell count (SCC) was included because it is a common benchmark and is also one indicator of udder health. Many studies utilize rolling herd average (RHA) as the production parameter of comparison. There is a lot of production history in this measure and something more indicative of current management effects was desired for this study. The parameters, 305 day mature equivalent (305d ME) and standardized 150-day milk were chosen for this study. They seemed to fit the snapshot in time of prevention practices being assessed.

The study outcomes focused on factors determined by the adult cow herd without a direct measure of calf performance. The first two years of a heifer’s life does not directly contribute to milk production or quality parameters. Given the number of calf biological risk management practices included in this study, two measureable outcomes would have helped interpretation. The first would have been mortality rate prior to weaning to provide a measure of disease challenges and management effects on newborn calves. Obtaining this value may have been an obstacle depending on record keeping abilities of the dairies. The second factor would have been age at first calving. This is provided on DHI herd summary sheets and could have been used to determine heifer management during their first two year’s of life.

Dairies selected by assessors as a convenience sample introduced an aspect to the study that was not anticipated. Multiple dairy breeds were represented in the study because they met the predetermined selection criteria. While the U.S. dairy population is not homogeneous and disease management practices apply regardless of the genetic make up of a herd, comparisons were complicated based on the information, or lack thereof, provided for every dairy.

Herd summary sheets from DHI were only provided for 38 herds. Breed variability could have been accounted for if all farms would have provided their summary sheet for the previous 12 months of testing. The parameter, energy corrected milk, could have been calculated for each herd which is determined by milk production, fat and protein values. This oversight in study design provided additional education in dealing with missing data and working with the best available data to provide meaningful results.

Missing data

In a convenience sample survey, complete cooperation of all subjects is often unattainable.(Longford, 2005) There are a variety of reasons for missing data such as study design, participant characteristics, measurement characteristics, data collection conditions, data management, and chance.(McKnight et al., 2007c) These independent causes can be additive if found in a single study, causing problems with data analysis, interpretation and generalization.

Assessors in California failed to report the production value, standardized 150 day milk. In examining provided California herd summary sheets, the parameter was not found, an example of a measurement characteristic. However, the term management level milk (MLM) was included and provides the same type of data for a herd. This variable could have been obtained if all herd summary sheets were provided or if the study design included a better explanation of the desired measurement to California assessors.

The 42 herds without corresponding DHI herd summary sheets could have been a result of the participants refusing to provide the information (participant characteristic). Data collection conditions may also have affected compliance. Despite making appointments to conduct the on-farm interview, interruptions could have occurred and the sheet forgotten. The collection tool could have been modified to increase the likelihood of collecting the data (study design). Some of the herd summary sheets could have been omitted purely by chance. Without this information, analysis was limited to the production parameter, 305 day mature equivalent (350d ME). If fat and protein data would have been available for all herds, additional production terms could have been calculated, increasing comparison across the 80 dairy operations. This limited generalization to the dairy population at large.

To minimize the loss of data during the transfer from the technician in California to the dissertation author, a two step process was utilized (data management). All data from the original pre-assessment questionnaire and DHI herd summary sheets, where applicable, were hand entered into a spreadsheet by the dissertation author. The California results entered by the technician were compared to ensure congruency. The Iowa results were entered a second time into a separate database and compared. The data from the assessment questionnaire were also compared to the results from the online BRM database.

Some of the assessment questions were not answered, resulting in missing values, referred to as item non-response.(McKnight et al., 2007c) The response choices for each question were ‘yes’, ‘no’ or ‘maybe’. There was not an option for ‘not applicable’ during the study due to its design. These non-responses were further evaluated. Based on responses to other questions for the same operation, missing responses occurred because that particular question did not apply to the dairy operation. These non-responses were not handled as missing; rather they were entered into the spreadsheet as ‘not applicable’ and analyzed accordingly. More information about responses to specific questions can be found in Chapter 3, ‘Development, testing and descriptive results for the biological risk management assessment of 80 dairies’.

Texts written on missing data refer to Donald Rubin’s 1976 classification system: missing completely at random (MCAR), missing at random (MAR), and missing not at random. (McKnight et al., 2007c) Two other terms have been introduced in recent years: ignorable or non-ignorable. (Allison, 2001a; Longford, 2005; McKnight et al., 2007c) These references were utilized to provide the following classification explanations.

Missing completely at random (MCAR) applies to data that has no relationship to observed data. As the name implies, the data is truly randomly missing and there is no systematic pattern or process to explain the way it is missing. In this dairy study, 42 herds did not provide a copy of their DHI herd summary sheet. To determine if it was missing completely at random, dairies that provided the summary sheet were compared to those who did not, using somatic cell count (SCC) as the response variable in logistic regression. There was no statistical difference (p=0.055) between these two groups, inferring the data were "observed at random" as related to SCC (data not shown).

Missing at random (MAR) applies to data that has a relationship to observed data but not to the missing data itself. There is an underlying systematic pattern to why it is missing. This pattern was not observed in the current study, but an example would be if dairies with a SCC greater than 400,000 cells/mL failed to report their culling data. Cows with high SCC are often removed from the herd due to the possibility for disease spread or decreased premium payments from the sale of milk. This could affect the cull rate of a herd. A pattern between cull rate and SCC would exist but not necessarily a pattern within cull rate alone. Herds that sell genetic stock could have higher cull rates but since data is not always available as to the reasons for culling, a distinct pattern within cull rate may not be determinable.

Missing not at random (MNAR) is harder to differentiate because the 'missingness' of the data is related to the values themselves. Since the data are unobservable, it is impossible to determine any type of relationship. In a cohort or case-control study, failure of a dairy producer to respond because he/she was unwilling to provide production information or answer questions is relevant and would be considered MNAR. This is also an example of non-ignorable data meaning it must be modeled in the final data analysis.

It should be noted that the only way to determine a difference between MAR and MNAR data is based on the researchers understanding of the data and sound logic. Combining descriptive analysis with statistics can help determine the best way to handle missing data and if randomness was involved.

Determining if data is ignorable or non-ignorable depends on the impact that missing value, or values, will have on the analyses and conclusions. Non-ignorable data need to be modeled in the parameter estimate. MAR or MCAR are the only types of data that can be ignored but differentiating MAR and MNAR can be difficult.

Once data is determined to be non-ignorable, it must be accounted for statistically. An extensive discussion of the analysis procedures is beyond the scope of this chapter, but the methods of listwise deletion, pairwise deletion, dummy variable adjustments, imputation and maximum likelihood are described in the literature.(Allison, 2001b; Allison, 2001c;

McKnight et al., 2007a; McKnight et al., 2007b) In this dairy study, the method of imputation was applied and the details of this analysis are discussed next.

Selecting and validating the dependent variable for milk production

The production parameter, projected 305 day mature equivalent (305d ME) adjusts the current production record for a cow to what she would be producing at three years of lactation or greater as a mature cow. Averages are adjusted for the cow's age and season of calving to obtain a standard value. It is designed to "level the playing field" between cows in the herd and between herds of the same breed.

There were 76 herds in the final data set; 38 herds provided a de-identified DHI herd summary sheet. For those provided, testing centers reported include AgriTech Analytics, AgSource/WisGraph, Dairy Record Management System (DRMS), Minnesota and Provo DHIA. Testing centers do not make their equations for calculating 305ME readily available. It was explained that if all centers used the same calculation and provided their equations, proprietary software would not be needed; thus the need to protect their info. Most provide the details considered in their equation and variations existed. For instance, DHI Provo and AgriTech Analytics 305ME estimates are adjusted by age of the animal, season/month of calving, region of the country, and breed of the animal.(DHI Provo, 2008) Minnesota DHI does not report factoring in breed or region. (Minnesota DHIA, 2008) DRMS reports adjusting for location but not breed, and also adjusting to twice a day milking if he herd is milked more than twice a day.(DHIA, 2007) AgSource, which also produces WisGraph factors in age, season of calving and region, but not breed. (Ron Curran, personal communication)

Attempt 1: Dependent variable – Holstein equivalent 305

In order to standardize all herds to one dependent variable for comparison purposes, a conversion factor for each of the non-Holstein breeds was created. (Table 1) This conversion factor was determined by taking the reported 305d ME for Holsteins and dividing it by the average 305d ME for herds in the same breed category based on data from Dairy Metrics 2007, Dairy Record Management System (DRMS).

Each reported 305d ME for the non-Holstein herd was multiplied by the corresponding breed conversion factor. This new dependent variable was called Holstein-Equivalent 305 (HE305). The HE305 median was 25,001 pounds and was used as the cut-off between high and low producing herds.

Table 1. Herd and cow enrollment in Dairy Herd Improvement (DHI) Test Plans[a] as of January 1, 2007 and in the biological risk management (BRM) study, by breed

	Guernsey	**Holstein**	**Jersey**	**Mixed***
DHI Herds	175	20,519	1,141	1,322
DHI Cows	7,589	3,886,632	186,136	159,909
BRM Herds (76)	1	60	7	8
DHI CA Herds	7	788	103	0
DHI CA Cows	466	891,506	66,277	0
BRM CA Herds (37)	0	31	5	1
DHI IA Herds	11	787	31	0
DHI IA Cows	798	101,053	3,793	0
BRM IA Herds (39)	1	29	2	7
DHI Herd Ave 305d ME[b] (lbs)	15,630 (64 herds)	22,996 (13,655 herds)	15,681 (639 herds)	18,653 (1,167 herds)
BRM Herd Ave 305d ME (lbs)	18,441	24,984	18,187	23,053
Conversion Factor	1.47	N/A	1.47	1.24

[a] Reference (ARS, 2007b)
[b] Reference (DRMS, 2007)
*Mixed herds are those with less than 75% of the herd consisting of the same breed. This could consist of 70% pure Holstein and 30% pure Jersey, or an entire herd of cross-bred animals.(Greg Palas, personal communication)

The conversion factor approach was presented to the Iowa State University College of Veterinary Medicine Dairy Group. They expressed concern because it was not a published parameter of comparison and it may not accurately predict production for the colored breeds (over inflation). They suggested using energy corrected milk (ECM) as the standard of comparison across herds.

Attempt 2: Dependent variable – energy corrected milk (ECM)

Energy corrected milk (ECM) is a value used by the dairy industry to standardize milk production, accounting for actual production, percent fat and percent protein. Given the variation of breeds in the data set, ECM was an appropriate dependent variable to use.

The calculation for ECM with a 3.5% fat and 3.2% protein is as follows (Smith et al., 2002b):

$$\text{ECM} = (0.3246 * \text{kg milk}) + (12.86 * \text{kg milk fat}) + (7.04 * \text{kg milk protein})$$
kg milk = Amount of milk, kg

All results were calculated on a pound basis for the herd rather than individual cows. The amount of milk was based on reported 305d ME. Herd level percentages were used for fat and protein. In all, 38 of the herds had values for %fat and %protein; 14 of the 16 colored breeds or mixed breed herds and 24 of the 60 Holstein herds. (Table 2)

Where actual fat/protein values were available, the Actual ECM was calculated for that herd. Where it was unavailable, the average conversion factor (CF) for that breed was used to estimate ECM. The average breed conversion factor (CF) was calculated as follows:

Breed CF = Actual ECM / Reported 305d ME
Average breed CF = breed CF / # of study herds in that breed

Table 2. Breed conversion factors (CF) for energy corrected milk (ECM)

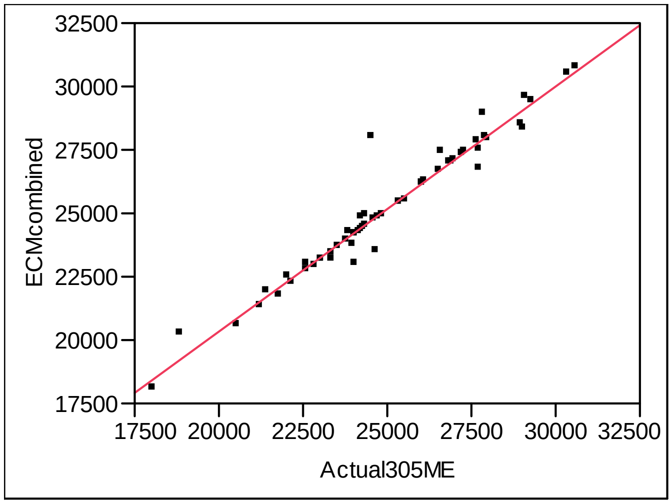
Breed	**Ave. Breed CF**	**No. Herds in Calculation**	**No. Herds Using CF**
Jersey	1.176	5	2
Guernsey	1.143	1	0
Mixed	1.028	8	0
Holstein	1.006	24	36

An estimated ECM was used for 38 herds. Using simple linear regression, reported 305d ME was compared with ECM for the 38 herds with data. There was a good fit of the line but no accounting for directionality. Some reported 305d MEs were higher than ECM, others were lower and it was not a function of breed.

Simple linear regression was used to compare the Holstein herds with Actual ECM and those with ECM-CF. (Figure 1) Again, good fit of the line but no directionality. The linear regression outliers were farms with actual ECM data. This was one reason to use reported 305d ME rather than a combination of Actual ECM and ECM-CF. Similarly the Jerseys had good fit of the line and had the smallest error based on the variance. (Figure 2) Mixed herds and the single Guernsey herd did not require a conversion factor.

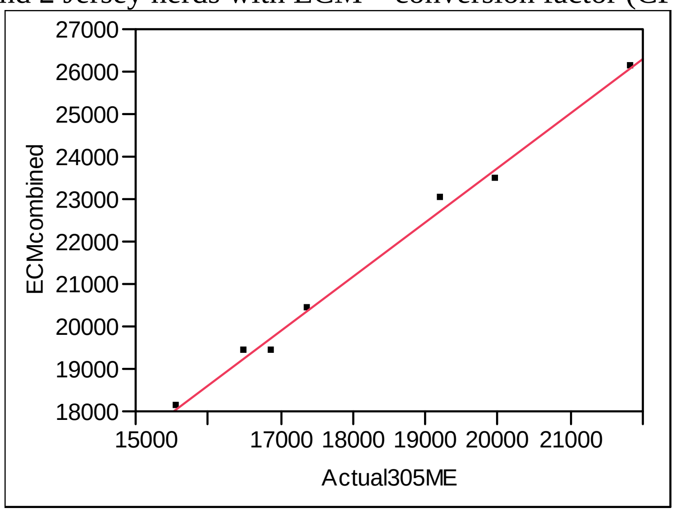
A combination of Actual ECM and ECM-CF for the 76 herds would allow for use of a continuous dependent variable. With a larger data set and fewer “missing” ECM values, a combination of Actual ECM with ECM-CF might be more appropriate. Directionality could not be determined for the 38 ECM-CF herds; thus this approach was deemed inappropriate.

Figure 1. Simple linear regression of 24 Holstein herds with actual energy corrected milk (ECM) and 36 Holstein herds with ECM – conversion factor (CF).



Goodness of fit: $R^2 = 0.9497$

Figure 2. Simple linear regression of 5 Jersey herds with actual energy corrected milk (ECM) and 2 Jersey herds with ECM – conversion factor (CF).



Goodness of fit: $R^2 = 0.9951$

Attempt 3: Dependent variable – reported 305d ME

While continuous data provides more information than dichotomized variables, the best available data for the study did not lend itself to using reported 305d ME or ECM for reasons previously described. Using an industry standard record system, DairyMetrics 2007, the breed average 305d ME plus one standard deviation was selected as the benchmark to compare each of the 76 herds in the dataset. Each of the 76 dairies in the data set was manually assigned to the high producing group or low, resulting in 26 high and 50 low producing herds. Student's *t*-test (H-L) revealed a significant difference in the means of 305ME of 3493.7 pounds ($p<0.0001$). (Table 3)

Table 3. Difference in the means ($p<0.0001$) of reported 305 day mature equivalent (305d ME) for the 76 high and low producing herds in the dairy study.

Production Category	No. Herds	305d ME Mean (lbs)	Std Dev	Lower 95%	Upper 95%
High	26	26,327.7	3,236.57	25,020	27,635
Low	50	22,834.0	2,753.12	22,052	23,616

In the final data analysis, herds were classified as high or low production based on this treatment of the production parameter. Dairy producers are used to comparing themselves to industry standards and ranking themselves as a high or low producing herd. This approach should be accepted by the industry.

Modifications to improve the usefulness of the tool for producers, advisors

Since release in March 2005, the online tool has been utilized to conduct 186 dairy assessments, 80 of which were for this study. Use of this tool has been incorporated into courses at Iowa State University and South Dakota State University for students to learn the importance of looking at a dairy operation from a variety of angles to identify vulnerabilities for disease entry or spread. A subset of members of the American Association of Bovine Practitioners (AABP) utilized this tool with their clients prior to attending a pre-conference seminar in 2006. Feedback from users was collected to improve the online user interface, questions, reports and communication tools.

Some prevention practices did not result in the expected outcome (positively associated with higher milk production, lower somatic cell count), so special attention was given to those to improve their validity. Rather than asking about cleaning waterers weekly, the focus was changed to determine the method of cleaning in an effort to clarify the relationship in future assessments. A question that seemed overly wordy and may have caused confusion, 'during chores, do you move from "clean" younger animals to "older" animals, to "dirty"/sick animals, and finally isolation animals?' was shortened in an effort to be more precise. More definitions were provided in the questions themselves related to the terms isolation and closed herd. Double-barreled questions (those with more than one topic) were altered so there was only one focus.

Questions from this study that were changed to increase clarity and precision are listed in Table 4. Other modifications were made to improve the quality of some of the original 210 questions. Some questions were removed, others combined to provide the same information but in fewer questions. Additional questions were added to account for changes in the industry (pasteurizing calf milk on farm, changes in rendering services).

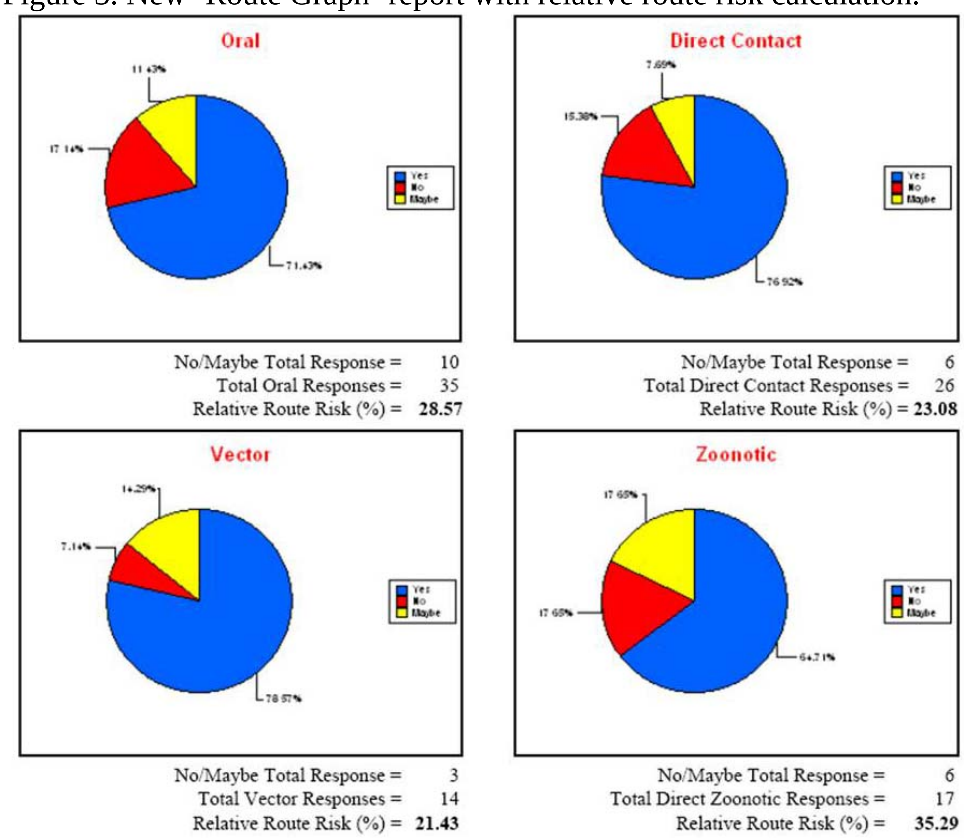
Table 4. Study questions with changes to increase clarity, precision for future use.

Question
Do you limit nose to nose contact between animals with different vaccination status?
Do you prevent the dead/render truck from entering your operation?
During chores, do you move from youngest to oldest and handle sick animals last?
Do you keep the areas where cows lay (stall, dry lot) clean and dry by scraping at least once daily?
Do you have a place to separate sick cows that prevents contact with healthy animals?
Do you have a closed herd, not introducing any new/returning animals?
Is your herd somatic cell count at or below 200,000?
Do you limit your calving pens to calving only and not for isolation (sick) animals?
Do you avoid feeding unpasteurized milk to calves (only feed pasteurized milk or milk replacer)?
Do you prevent direct contact between unweaned calves?
When you clean waterers, do you drain and remove all build-up/sediment before refilling?
Do you avoid feeding leftover/uneaten feed from lactating animals to young stock (less than 12 months old)?

The assessment questionnaires originally included the response choices, ‘yes’, ‘no’ and ‘maybe’. Based on results of the study, a fourth choice was added, ‘not applicable’ (N/A). In some cases, the question may not apply to the dairy and rather than have a skipped response, indicating a possible missing variable, ‘not applicable’ can be entered into the database. This response was reported in the Management Recommendation reports and the All Response reports. It did change the Route Graph report.

The Route Graph (route of transmission) report provided the percent ‘yes’ and ‘no/maybe’ for each route (aerosol, direct contact, fomite, oral, vector, and zoonotic) based the number of responses entered into the online database. This report was challenging for assessors to interpret due to the variation in denominators across routes. Therefore, it was modified to improve usefulness. Programming was included to provide a ‘relative route risk’ that calculated a percent based on the total number of no/maybe responses divided by the total number of responses for each route. (Figure 3) These percentages can then be evaluated across all routes. It still did not provide a direct comparison, but percentages were easier for users to determine the ‘big picture’.

Figure 3. New ‘Route Graph’ report with relative route risk calculation.



It was suggested that the management recommendation reports include the coding for each route next to each question. This would better allow users to interpret this report in conjunction with the route of transmission graphs and provide accompanying communication handouts. The current reporting software has not allowed for this to occur. This feature would enhance user interpretation of the route of transmission approach and is on a future wish list of improvements.

Data from the pre-assessment questionnaires cannot be entered into the online database. Developing a user interface that would allow for voluntary data entry for milk production and quality parameters could lead to a more robust data set. Desired values would be total number of lactating cows, percent first lactation animals, breed(s) with percent, actual 305d ME, percent fat and protein, herd average somatic cell count, percent of herd injected with bovine somatotropin, milking frequency, days in milk, cull rate, and age at first calving. Continued analysis and comparisons could be made with the same set of questions over time to identify trends, improvements or declines to drive future research inquiries. Much like commercial dairy record software programs, benchmarks could be generated regarding prevention practices. This might entice more dairy producers to participate and provide information on the state of the industry with respect to disease management.

Conclusions

This project provided a number of learning opportunities for dealing with convenience sample data, information provided by third-party data collectors, and analyzing large data sets with the best information available. The limitations will limit broad generalization to all U.S. dairy operations. However, as an initial validation, this approach provided informative results (explained in detail in Chapter 4) that could be used as discussion points with dairy producers concerned with disease entry or spread on their operation.

Future studies should use the new and improved risk management assessment questionnaire and production data should come from DHI herd summary sheets. To add importance to certain practices, an expert panel could be formed to rank each question, providing a weighted measure in the final analysis. All prevention practices are not equal in their ability to limit exposure. Future studies would benefit from a ranking approach combined with production information to determine association.

If multiple breeds are enrolled in future studies, energy corrected milk should be the milk production parameter of comparison. For broader application, dairies should be enrolled in a randomized manner and one person should be responsible for on-farm data collection.

Additional enhancements could be made to the online BRM database to enhance reporting, collect additional data and provide the industry and dairy researchers with additional information regarding on-farm disease management practices.

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Chapter 6. General conclusions

Contributions to science

Dairy biological risk management information

The dairy biological risk management (BRM) background document was developed using a multitude of resources. Thirty-seven pages described the scope of the dairy industry and the importance of disease risk management. A 28-page condensed version, “Dairy BRM – Key Points” described the same information but in a bulleted format for quick reference by producers and their advisors. The topics of risk perception, risk management and risk communication were discussed. A section was also devoted to human traffic (employees and visitors) on the dairy and preventing zoonotic diseases.

The risk management section of the document provided a review of the life stages of a dairy animal and described the variability in management styles. Disease management practices were outlined for various housing types, milking procedures, dry cows, pre-fresh cows, calving, replacement heifers and handling newly introduced animals. Biological risk management protocols focused on the routes of disease transmission (aerosol, direct contact, fomite, oral, and vector-borne). This was a novel approach to managing disease exposure and the method was applied in the development of the assessment questions, final reports and communication tools.

This document was peer-reviewed by three dairy veterinarians as well as selected members of the American Association of Bovine Practitioners. Sections of it were printed in lay publications to educate producers. It also provided background information for the developers of the U.S. Department of Agriculture, National Animal Health Emergency Management System Guidelines, March 2007 Facility Manual for the Dairy Industry.

Assessment questionnaires were developed to coincide with the information in the dairy BRM background document. Over 200 closed-ended assessment questions inquire about published or industry recommended practices that should reduce the risk of disease entry or spread. Each assessment question was worded such that if the producer was performing the prevention practice he/she answered ‘yes’. Estimating probability of disease and the consequences were not included in the initial BRM assessment due to the complex modeling required to perform the task. The goal of the questionnaire was to increase dairy producer awareness of disease prevention practices during the on farm assessment.

Each assessment question was assigned to one or multiple transmission-route categories (aerosol, direct contact, fomite, oral, vector or zoonotic) which was used in the final reports. Management recommendations were written for each assessment question using scientific data wherever possible. The recommendation often incorporated statements addressing the route(s) of disease transmission identified for that question. In all, 226 unique management recommendations were developed.

The dairy BRM background document, key points, and a multitude of communication handouts are available online as a free educational resource. The assessment questionnaires and corresponding reports were developed into a user-friendly, readily accessible, free online database for dairy producers and their advisors to use to identify the risks to disease introduction and spread. Nearly 200 dairy assessments have been completed since its release in March 2005. Registration is required for the free database. All information can be found at: www.cfsph.iastate.edu/brm.

Validation of BRM recommendations

Validation of these recommendations was needed. Two questionnaires were used to collect data from 80 dairies in California and the Midwest. A three-page pre-assessment questionnaire included 14 open-ended questions pertaining to herd demographics, production parameters (305 day mature equivalent [305d ME], somatic cell count [SCC}), animal introduction, visitor protocols, isolation facilities and risk perception. A three-page assessment questionnaire consisted of 45 closed-ended questions addressed animal contact, visitor/employee protocols, hygiene, milking procedures, colostrum and calf management, and feed and manure handling. Developing effective questionnaires involved peer review, formative evaluation and pilot testing in a variety of formats.

Vulnerabilities on the 80 dairies were identified and included new or returning animal introductions, lack of isolation or quarantine facilities, an absence of protocols for visitors or employees with animal contact, lack of a necropsy for animals dying of unknown cause, and not minimizing young stock exposure to manure.

A method was developed for correlating production parameters (305 day mature equivalent and somatic cell count) with various prevention practices. Biologically plausible and informative practices were evaluated for those that performed the practice and those that did not as compared to the production parameter. Responses to each question tended to cluster based on animal level exposure (aerosol, direct contact, fomite, oral, and vector-borne). From a disease exposure standpoint, critical control points for each route of transmission should naturally group together.

The overall purpose of this study was to identify which practices were positively associated with higher milk production (305d ME) and lower SCC. Introducing animals to a herd did not prove significant as an effect of all variables in the final model, but it remains a critical control point as an independent prevention practice for both milk production and quality.

Prevention practices that correlated with higher milk production and lower somatic cell count included management styles characterized as 'attention to detail'. For instance, fly control, inspecting animals daily and cleaning alleyways. Practices aimed at minimizing disease exposure to calves included prompt removal at birth, obtaining colostrum within two hours, second colostrum feeding, and preventing exposure to manure pathogens positively correlated with increased milk production and quality on a herd level.

Future studies should use a modified risk management assessment questionnaire and production data should come from DHI herd summary sheets. To add importance to certain practices, an expert panel could be formed to rank each question, providing a weighted measure in the final analysis. All prevention practices are not equal in their ability to limit exposure. Future studies would benefit from a ranking approach combined with production information to determine association.

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To my committee members: Dr. Dale Moore for financing the California project, supporting my efforts every step of the way, pushing me to learn new analyses, and countless editing hours to make me a better writer; Dr. Leo Timms for his friendship, support, willingness to incorporate BRM into the senior year dairy course and being an inspiration to someone who hopes to contribute one-tenth of what he has to the dairy industry; Dr. Ron Griffith for pushing me to learn new things and keeping it practical; and Dr. John Thomson for supporting the 'kid from South Dakota' as she continued her higher educational career.

Thanks to the data collectors in California and Iowa and the ISU students. Thanks to Marla Truscott for keeping the California data so organized. To all the dairy producers, whoever you were – thanks for your participation in this study, hard work and tireless efforts to provide food for the world!

It was a privilege to work with my colleagues, the BRM development team: Drs. Alex Ramirez, Glenda Dvorak, Carrie Hammer, Jared Taylor, Katie Steneroden, LeMac' Morris, Stacy Holzbauer, Babasola Olugasa and Dipa Brahmbhatt; the BRM database development and improvement team: Kris McBride, Andy Gould, Travis Engelhaupt, Clint May, and Venkat Rao. Thanks also to Naomi Backous with her help with the appendices and formatting, Dawne Buhrow for getting the field specialists paid and Jane for writing those grants!

Appendix 1. Dairy biological risk management (BRM) background document

Dairy Biological Risk Management

March 2005

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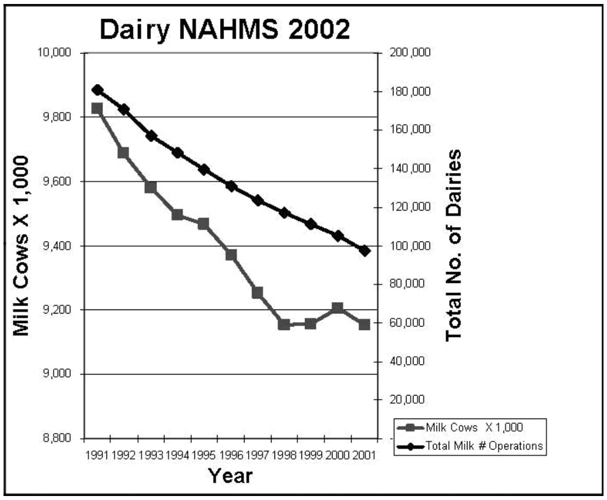
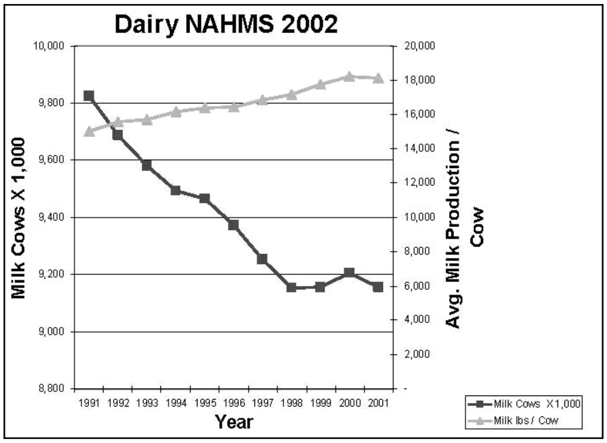
Introduction

The dairy cattle industry has undergone dramatic changes in the last two decades. Some of these changes have included declining operation numbers, increasing herd sizes, an increase of milk production per cow, and farm specialization. While farms continue to get larger, there are still a considerable number of small to medium sized dairies that continue to raise their own heifers and feedstuffs while producing quality milk. This variation in economic base and production style does not end with the number of cattle raised on farm. When designing a biological risk management plan for dairies, one size does not fit all, and we will discuss how to assess different farming operations later in this paper.

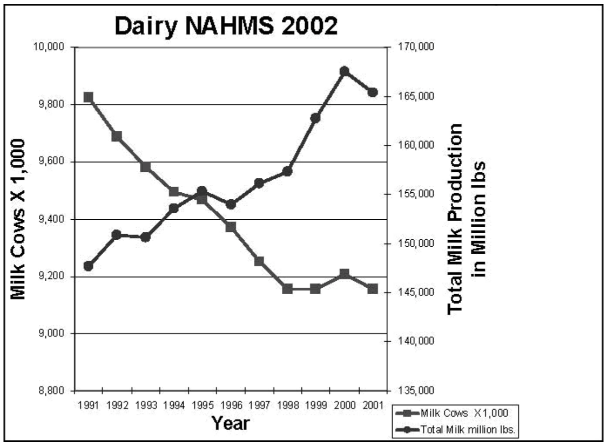
The following three graphs from the Dairy National Animal Health Monitoring System (NAHMS) study of 2002 enables us to identify the direction the industry has taken over the past several years. The graphs are from 1991-2001 and indicate a decline in operation numbers, but also indicate the number of animals and the average milk production per cow are increasing. These trends within the United States dairy industry directly impact the design of biological risk management plans and a breach could have more costly consequences.



Total Number of Dairies indicates the total number of cows in the U.S. has decreased from about 9.83 million to 9.16 million. At the same time, the total number of dairies has decreased from 180,640 to 97,560 operations. This amounts to a 46% decrease in dairy operations accompanied by only a 6.8% decrease in milk cow inventories during these 10 years.



Average Milk Production/Cow shows that while total cow inventories have decreased, the average pounds of milk produced per cow increased from 15,031 to 18,138. That is a 20.7% increase in productivity.



Total Milk Production demonstrates the combined effect of less cows (6.8%) accompanied by an increase in productivity (20.7%) resulting in a total U.S. milk production going from 147,697 million pounds of milk in 1991 to 165,336 million pounds in 2001. This is a net increase of 11.9% of milk being produced.

Importance of Dairy BRM

The dairy industry prides itself in producing a wholesome, safe product. Milk supplies 73% of the calcium to the U.S. food supply which is vital to the health of children, growing young adults and the elderly. Using the NAHMS 2001 total milk production of 165 billion pounds of milk, this would translate into a total of 19.8 billion gallons of milk which can be made into 16.5 billion pounds of cheese, 7.8 billion pounds of butter, or 13.8 billion gallons of ice cream!

As people move farther away from the farm and their food source, dairy producers have to become better promoters of their quality product, in ways never thought of before. Petting zoos and visitor days are becoming more common across the U.S. to give children and their families a better sense of what dairy production is all about. While it is a great idea and builds a sense of understanding among consumers, it is not without risk.

To illustrate this point, let us look at an outbreak of *Escherichia coli* O157:H7 infections among visitors to a dairy farm in Pennsylvania. This dairy farm had 216 head of cattle, of which 40 were adult cows. The farm was often visited by the public, especially groups of children, to see and pet the animals. In September 2000, there were 15 confirmed and 36 probable cases of E. coli O157:H7 in people who had recently visited this farm. A majority of the cases (92%) were in children under 10 years of age. Fortunately no children died, but one child developed endstage renal failure and required a kidney transplant. A comprehensive epidemiological investigation identified 33 of the 216 cattle at this dairy (15%) were colonized with E. coli O157:H7. This high rate of colonization was thought to indicate a recent exposure of the herd to E. coli O157:H7.

However, this farm environment can be made safer for visitors with some basic hygiene principles. Strategies include:

- The use of hand washing, including stations accessible to young visitors,
- Controlled and supervised contact with animals, and
- Clear separation of food-related activities from those areas housing animals.

These are the concepts surrounding biologic risk management. Simple steps can be taken that have minimal expense to achieve the desired goal of a biologically safer environment for both animals and people.

Interesting to note, no residents or employees of the farm reported having diarrhea during the outbreak period. Past exposure could have provided immunity to those working at the farm and their ability to stay healthy was not necessarily due to lack of exposure. The zoonotic implication of this outbreak also demonstrates the importance of biologic risk management. Could one of the employees or owners at this Pennsylvania farm (or the farm you are actually visiting), possibly have carried this E. coli O157:H7 home and exposed one of their children to this organism? What if it were salmonellosis? Increasing awareness to the potential risks helps everyone prepare for the unexpected.

BRM provides an excellent opportunity to evaluate and act upon ways to continue to safeguard the dairy industry and the people working within it against diseases. The information provided in this material is to help you establish a comfort level in evaluating biological risk management for your clients. Evaluation of different operations will highlight the strengths as well as the weaknesses for each of them.

Risk Perception

The category of risk perception examines what those involved with the operation think about the real and potential risks of infectious and zoonotic diseases. These perceptions may be influenced by what has been encountered on the farm in the past, or by what owners, managers, and employees may have read in magazines, on the internet, or in the paper.

This is also the period where one may encounter many of the obstacles and challenges to educating about risk management. Many individuals have negative perceptions associated with risk management, most of which are based around ideas of disbelief or economic concerns. Common negative beliefs include:

- I already know this stuff
- We have always done it this way
- I've already had most everything on this farm
- I don't have enough time to mess with this
- It's too complicated
- It won't make any difference
- It's too expensive
- I don't have the space
- Our animals were tested once and we found nothing, it was just a waste of money
- Our farm is pretty safe

Disease risk cannot be totally eliminated, but attention paid to biological risk management can reduce risks and their consequences. While it is difficult to prove and measure the benefit of things that **don't** happen, counter-arguments tend to fall into three categories:

there is a risk, it is economically worthwhile to prepare, and the overall impact must be considered.

- Infectious/zoonotic disease outbreaks can and do happen as the E. coli example above illustrated.
- Prevention is always less costly than treatment.
- Protecting your financial investment and your future assets from liability is worthwhile insurance.
- Protecting employees saves time and money.
- A biological risk management plan established and followed will help manage the threat of foreign animal disease entry and spread.
- A focus on preventative medicine helps to maximize public and environmental health of your community.
- Prevention of disease through awareness and management of infectious disease risk is an important part of decreasing the potential for antibiotic resistance and its consequences.

Risk Assessment

To increase its effectiveness and completeness, a comprehensive risk assessment should be performed from a variety of perspectives. First and foremost, the general herd characteristics and farm policies should be examined through a pre-assessment questionnaire (see Pre-Farm Questionnaire in handouts).

In reviewing this material, it is imperative to understand that the focus is on routes of transmission, not specific disease entities. Assessing risk based on route of transmission provides a more complete and holistic approach and avoids emphasizing specific disease(s). The only references made to specific diseases, syndromes or infectious agents in this material are for illustrative purposes only, and there are no specific recommendations provided as to vaccination, treatment or testing procedures. This focus will make the information applicable to a variety of audiences and remain relevant even as scientific advances improve our understanding of diseases.

Risk Management

The documents illustrate the best available “standard operating procedures” for a wide range of management practices. Each veterinarian should perform a thorough assessment to identify opportunities for improvement. Then the management suggestions should be considered as to which ones are most practical, applicable, and economically feasible. Most recommendations can be implemented independent of others. This will result in tailoring the BRM program for each producer based upon his/her preferences, resources, risk perception and risk tolerance. Some suggestions may not be feasible for a given facility; but recognizing what is optimum helps establish long term goals.

Herd Characteristics

Lactating Cows

This is the primary animal species on any given dairy. They can be housed in a variety of ways, each with its own strengths and weaknesses in regards to disease risk.

Confinement facilities- often consist of a free stall building with 2, 3, 4, or 6 rows of stalls in the barn where the cattle are housed and generally remain inside all day every day. There is one stall per animal or per 1.2 animals depending on the facility. Stalls should be bedded with a material that does not enhance organism growth. The stalls should be groomed to remove manure and urine buildup at every milking and fresh bedding added frequently. The feed alley is commonly in the center or along one side of the building and there are large openings along the sides and ends for ventilation and traffic flow. There are automatic trough waterers in each of the large pens that provide water to the cattle in the pen. Cattle generally travel down covered alleys to the milking parlor; there may be additional automatic water troughs in the return lane(s). The primary flooring surface is concrete, but rubber belting is being used more in traffic areas and near the feed bunk. Manure can be removed by manually scraping the
stalls, and using a skid steer with a blade/rubber tire to scrape the manure lengthwise down the alleys to a grate system with augers to move it outside to a collection area or manure storage. A recently adopted method of removal is through the use of vacuum trucks or implements. There are also automatic scrapers that run on a pulley system and scrape manure to the end of the alleys multiple times a day. Finally, there are water flush systems that use gravity flow to wash the excrement down the length of the barn into an underground storage system multiple times a day. These facilities can be used to house thousands of cows.

Dry lot facilities- often consist of multiple dirt lots with shade structures for the cattle to escape the sun and weather; more often used in warmer climates. The feed bunks are located on the edges of the dirt lots. Protective covers over the feeders may be present to shelter the cows while they eat and to keep the feed dry when it rains. There are automatic water troughs or wells scattered throughout the dirt lots. The milking parlor is a covered structure, generally centrally located to all the lots, so the cattle are moved through the lots and up dirt alleyways to be milked. There may be automatic water troughs in the return lane(s). The lots are groomed one to multiple times per day using a tractor and drag system. Manure is spread out so that the sun can dry it. Depending on weather conditions and animal density, lots will be scraped so that the top layer of dirt and excrement is removed. Manure storage options vary. These farms can be used to house thousands of animals.

Rotational grazing- this consists of multiple grass and forage-based pastures in which the cows spend their time in between milkings. There may or may not be a feed bunk in the pasture depending on the quality of the grasses and the need for supplemental feeding. Watering sources vary within this production method. There may be a natural stream in the pasture, automatic waterers may be set up near the fence lines, well water may be the primary source, or multiple livestock tanks that require manual filling multiple times per day. Cattle are moved to a covered milking parlor through other pastures or dirt paths. Fencing is usually a series of high tensile wire, not permanent, so that it can be moved based on the growth patterns of the grasses. This method is used throughout the United States, but in northern climates it can only be utilized 4-5 months of the year. Manure is allowed to remain in the pastures as a fertilizer and often the sun dries it out. These facilities are typically used for farms less than 500 cows.

Tie stall/stanchion facilities- this consists of a covered barn, often with solid walls and individual stalls for each of the cows. A tether system is used to confine each cow to her stall; either the cow wears a collar around her neck and is chained to the front of the stall or there is a movable head catch at the front of the stall that restrains the cow around her neck. There is one stall per animal. Stalls should be bedded with a material that does not enhance organism growth. The stalls should be groomed to remove manure and urine buildup at every milking and fresh bedding added frequently. Manure is manually scraped from the back of the stalls into a conveyer at the back end of the stall. It is then automatically moved to the end of the barn where it can be piled on a cement lot or directly into a manure spreader. There are individual feeding areas, or mangers, in front of every cow and a drinking fountain at every stall or every other stall. Cattle remain in their stalls for milking and the equipment is brought to them. There is an overhead pipeline that the milking units connect to so the milk can be moved via gravity to the bulk tank in the milk room. During good weather, cattle are often turned out into a dirt lot, cement or pasture area. Centralized feed bunks, covered or uncovered, and automatic water troughs are generally located in an area near the barn where the cows can be fed during warmer times of the year. These facilities are typically used for farms less than 150 cows.

Milking Procedures

One of the diseases dairy producers deal with on a regular basis is mastitis. The process of milking cows, when done properly, poses very little risk to developing disease. However, there are so many variables involved in milking and it is difficult to ensure that proper procedures are always followed. For these reasons, mastitis will continue to occur. We need to focus on minimizing that risk.

The mechanical variable, the milking unit itself, should be monitored to make sure the vacuum levels are correct, pulsators are working correctly, and the liners are changed on a set schedule depending on their composition, use and wear. Automatic take-offs set appropriately for removal at the end of milking. These are critical steps to make sure the teat end does not experience unnecessary vacuum pressure or massage that induces damage. There are various recommendations available from the National Mastitis Council, various universities and extension, as well as equipment manufacturers. System checks should be done at least yearly, more often if problems are noted. If the teat end is healthy (smooth, soft), it functions as a natural barrier to pathogen entry into the mammary gland. Dry, cracked, and hyperkeratotic teat ends have less of a natural barrier and more potential for pathogens to enter. Research looked at teat-end integrity and those with cracked teat-ends had higher odds of developing a new intramammary infection (IMI) than those without cracks- 15% and 10% (Dingwell RT, et al 2004). While faulty mechanics of the milking equipment are often to blame, teat end damage can result from changes in weather conditions (cold, wind, chapping, frostbite), inappropriate teat dips, damage from other cows (sucking, stepped on) bedding type, and physiological differences in teat ends.

The human variable, the people/person milking the cows, is another consideration when conducting risk assessments to make sure proper procedure is followed time after time. Cows are creatures of habit and so should be the milking process. Studies that looked at complete lactation showed a 5.5% increase in lactational yield when a standardized milking procedure was used. (Rasmussen, Frimer 1990) Experts have reviewed the physiology behind milk let down and a fairly common procedure has been recommended to maximize the milk out process (details will be discussed later). To minimize disease risk during milking, milkers should wear disposable gloves. This will help protect their hands from any organisms that may be on the udder or in the milk and protect the teat end from any organisms that may be on that person's hands. To minimize over-milking of the teat end and subsequent damage, proper stimulation is needed for milk let down. It is important to milk a clean, dry teat to minimize bacteria in the milk and in the milking unit.

The order of milking cows is an important consideration when minimizing disease transmission. First lactation cows should be first, older cows with low somatic cell counts (SCC) next, then those with higher SCC, and finally, clinical mastitis cases. This reduces cow-to-cow transmission of organisms by milking the most susceptible, least resistant animals first when the equipment is the cleanest.

<u>Step one- forestripping</u>. This step allows physical stimulation of the teat and udder to help the cow "let down" her milk. From a disease standpoint, which is the focus of this paper, forestripping allows identification of abnormalities in the fore-milk. Forestripping has been shown to decrease the risk of Listeria monocytogenes contamination in the milk by 2.5 times (Midwest Dairy Business 2004). Not every facility practices forestripping, and many complain of the extra time it takes to do so. Studies vary in their results as to whether or not this step in the milking process lengthens or reduces milk-out time. This step should be evaluated for effectiveness at each facility because factors such as a cow's days in milk, breed, udder cleanliness, total udder preparation time, and teat-end integrity affect the successfulness of this step in regards to milk out time. It should be noted that forestripping often precedes cleaning the teat ends. Cows with a lot of organic debris on their teat ends will benefit from a cleaning step first in order to prevent pathogens from entering the teat end once the teat canal is opened with forestripping. The reason for forestripping before cleaning is so that once the teat end is cleaned and dry; the milking unit can be attached. Some will pre-dip (see below), forestrip, then wipe, which is also an accepted process. The key to disease prevention is to limit bacterial uptake into the teat canal.

<u>Step two- cleaning the teat ends</u>. This can be done in a dry prep or pre-dipping manner, each with inherent disease risks and benefits. Dry prep involves manually wiping the teats with a dry towel or dry gloved hand to remove some of the organic debris and to stimulate the cow to let down her milk, depending on contact time. While this is less expensive due to no purchase costs of product, this is not the best way to clean teats prior to milking. According to a study at Cornell, cows that underwent no teat preparation, dry wiping or wetting/washing the udder and appeared to have visibly clean teats still had 3-16 times

more bacteria in their milk as compared to cows that were properly prepped. (Galton, DM, et al 1986 and Galton, DM, et al 1988).

Properly prepped teats also resulted in fewer infections. Cornell and Vermont studies demonstrated that pre-dipping reduced new mastitis infections 43-51% more than just washing and drying teats. (Pankey JW, et al 1987 and Galton, DM et al 1988)

Proper teat preparation involves pre-dipping the teats with a disinfectant solution approved for use in dairy cattle. It is important that the pre-dip achieve full coverage of all sides of all teats, allowing it to have 15-20 seconds of contact time to effectively kill the bacteria and then manually drying with a paper or cloth single use towel. Preferably pre-dip should be applied using a dip container versus application with a sprayer. If there is a concern for environmental mastitis pathogens being on the teat skin, contact time may need to be increased to 30 seconds to effectively kill the bacteria.

<u>Step three- wiping the teat</u>. It is important to remove the disinfectant completely and dry the teat before attaching the milking unit. This will prevent residue from entering the milk supply and minimize liner slippage on a wet teat. There are various different wipes on the market. Some are all-in-one disinfectants, others are paper disposable towels, and there are washable cloths that can be used. It is important that producers select what product works best for his/her facility based on the types of pathogens commonly found in your mastitis cases. Disposable towels used once have little risk of disease spread if handled properly (used once and disposed of without handling it in your hands before touching another cow). Washable cloth towels work well but should be laundered with detergent and/or bleach and completely dried on a hot temperature setting after every use. Wet towels can harbor bacteria so the drying process is vitally important to limit disease spread between milkings and cows. An all-in-one disinfectant towel has good efficacy if used properly, but it is essential the teat end is dry before the milking unit is attached to minimize slipping and subsequent teat end damage. Air drying is not always adequate after using pre-moistened towels. Again, individual farm assessment must be done to select the best pre-dipping and wiping method.

All pre-dips and post-dips are not created equal and are not currently regulated by the Food and Drug Administration. It is important to understand that pre-dips focus their bactericidal activity on environmental pathogens, whereas post-dips function to kill contagious pathogens. The National Mastitis Council (NMC) originally established a series of standardized tests that allow manufacturers to evaluate pre- and post-dipping products on a voluntary basis in the 1970’s. The products are tested under field and laboratory conditions and rated based on efficacy. The NMC recently reviewed their recommended protocols and revised them to reflect new technologies, enhance the scientific merit of testing, and to further standardize testing procedures. What was formerly known as Protocol A, B and C products are now based on experimental exposure to mastitis pathogens, efficacy based on reduction of new infections, and comparing known efficacy products to new products based on infection rate. They are also to only be used as the testing indicated- as a pre-dip or a post-dip.

Step four- attaching the milking unit. It is recommended that to achieve maximum milk let down and flow that milking units be attached within 60-90 seconds after first touching the cows teat, either by forestripping, pre-dipping or wiping. Regardless of the time factor, the focus should be to milk clean, dry teats that are ready to be milked so that over milking does not occur before full let down. This is good management to prevent pathogen entry into the teat end. Monitor the milking unit for liner slips throughout milking. These can occur at any time but occur most often near the end of milking, which can cause tiny droplets of milk to be propelled back into the teat end. If there are pathogens in this milk and milk flow is slowing down, the bacteria could enter the udder and not be flushed out, predisposing the cow to infection.

Step five- removing the milking unit. The vacuum should always be shut off prior to removing the milking unit so that liner slip is minimized and so are new infections. Facilities with automatic take-offs should have them set for a minimum output before removing the unit. An udder should not be milked completely dry because it could be more predisposed to pathogen entry and infection.

Step six- post-dipping the cows. After milking, the lower third of the teat should be dipped in a teat antiseptic to minimize the risk of contagious organisms entering the teat. Effective postdips destroy organisms on teats and prevent teat canal colonization. The herd veterinarian can help decide the product best suited to the types of organisms on the dairy facility. An excellent resource is the "Summary of Peer-reviewed publications on efficacy of pre-milking and postmilking teat disinfectants published since 1980" which was last updated in January 2004. (See Teat Dip Summary) In cold weather, when temperatures drop below 10$_o$F or if wind chill is a concern, the protocol should be altered slightly. Dip the teats; allow contact for 30 seconds, then wipe off excess liquid with a single use paper or cloth towel to minimize frost bite and teat end damage.

During milking, the teat sphincter opens and closes 60 times a minute and it takes 30-45 minutes for it to close with a keratin plug after milking. It is a good management practice to keep cows on their feet during this time so that they do not lie down in a contaminated area and allow organisms to enter the teat before the keratin plug is formed. Offering fresh feed so that it is available after milking will encourage cows to go to the feed bunk and water trough instead of laying down right away, helping that natural barrier protect the mammary gland from infection.

Hospital Pens and Facilities

Some dairies have a dedicated treatment and confinement area for lactating cows. The use of these hospital or recovery areas facilitates re-treatment and provides isolation and protection from violative milk residues. Cattle remain in these areas until they cure infection and/or clear violative milk residues. The treatment area and dedicated instruments easily serve as fomites since they are dedicated to handling the ill and injured animals. Cleaning and disinfection of facilities and instruments should occur after each procedure in an effort to control the spread of disease agents.

The hospital area is designed to provide a place to manage illnesses and injuries and to allow recovery, which can present special disease risks. Often they become a location to house the chronically ill and dying, or become a point source for new infections such as *Salmonella* or *Mycoplasma* mastitis. All animals that enter a hospital pen should be considered new entries into the herd when they return to their home pen. They should be made to pass entry procedures such as an obligatory milk culture (such as *Mycoplasma* and *Staphylococcus aureus*) before entry. A strategy that has been employed to control disease risk in the hospital area is to create pens dedicated to specific entities such as S. aureus or Mycoplasma spp mastitis, lameness and other disease conditions.

The movement of animals to the hospital pen could be minimized through the use of nonviolative therapeutic agents. Conversely, when treatment with a therapeutic agent that causes residues is required, it should be performed as soon as possible, at full dose and duration, and the cow should be moved. Movement forces resocialization when cows enter the hospital area and again when they return to their home pen. Resocialization can create immunosuppressive stress through reduced dry matter intake and animal to animal bullying. Combine this stress to the immunosuppression of the disease process itself and it becomes a significant biological risk factor. The hospital pen should be cleaned or scraped and bedded deeply with dry material to minimize stress. The cleaning equipment should be cleaned and sanitized prior to use in the rest of the herd.

An additional risk for the hospital area is the lack of a clear definition for this area. If recently fresh animals are moved to this area to facilitate treatment and monitoring, a risk exists due to immune system depression approximately two days prior to calving and up to ten days after. Recently freshened cows should not be housed with potentially infectious animals.

Dry Cows

There are different ways to group and house non-lactating cows, again each with it strengths and weaknesses. Dry cows can be split up into those that are far-off or just ending their lactation cycle, and those that are pre-fresh or due to calve within 3 weeks. Each has different nutrient needs but they are similar in their disease risk and so will be discussed together.

Cows that were recently dried off should be moved to an area that is clean and dry so that organisms are not able to enter the teat end, as the sphincter is not tightly closed and the keratin plug does not form for several days to weeks after the final milking. In some cows, the teats remained open until six weeks after dry off (23% of all cows according to research by Dingwell RT, et al, 2004; Also in this study of 300 cows, 11% of quarters developed a new IMI in the dry period). This makes them vulnerable to pathogen introduction and subsequent mastitis post-calving. Depending on the amount of milk production at dry off, udders may become swollen due to milk filling the mammary glands. Initially, milk may leak from the teat ends, so an absorbent, clean bedding material (straw, kiln-dried sawdust, paper) or one that allows drainage (sand, pasture) should be provided for the cows to lie on, again, so that pathogens are not able to enter the teat canal.

As cows approach calving, they should be fed appropriately, so that the colostrum is of optimal quality for the newborn calf, and housed in a clean, dry environment. First calf heifers, depending on their size, may need to be housed separately from pre-fresh cows. Besides the risk of disease transmission between different ages of animals, competition and dry matter intake differences may dictate separate pens and rations for these two groups of animals. Fresh feed specially formulated for their energy, protein, vitamin, and mineral needs and clean water should be made available at all times, again to maximize colostrum quality and ensure a healthy calf.

Calving Pens

Calving pens should be well bedded, clean, draft-free, dry and free of fecal matter build up. Ideally upon fetal presentation, each cow or heifer should have their own calving pen so that organisms are not passed between animals (fecal, oral, fomite, aerosol or direct contact) or to their newborn calves. Prior to colostrum collection, the cows and heifers should have their udder and teats washed with warm water and a mild detergent soap to remove feces and debris. Depending on the hair growth of the cow or heifer, clipping or singeing excess hair from the udder may also be warranted if proper restraint is available. Making sure the udder and teats are as clean as possible ensures that the colostrum can be removed without fecal or environmental contamination. This limits oral and direct contact disease transmission.

Following calving, the pen is then cleaned for the next individual. Deep straw bedding (1-2 feet) helps drain away the birthing materials (amniotic fluid, placenta, and blood) and animal excrement. Deep bedding will also inhibit the newborn calf from standing and wandering around the pen, trying to nurse on everything. One teaspoon of feces has enough E. coli, Johne's, etc bacteria in it to establish infection in a naïve animal.

The calving pen should be monitored every two hours and the newborn calves removed promptly after birth and placed individually in a clean, dry, draft free area. Depending on the degree of environmental contamination of the calving area, the navel could be dipped in a 7% tincture of iodine solution to facilitate drying of the umbilicus to minimize pathogen entry into the abdomen of the calf. Colostrum collected from its dam should be fed within 6 hours after birth and calves should receive >5% of their body weight. Large breed calves should receive ¾ to 1 gallon in the first 6 hours after birth, and another ½ gallon at 12 hour intervals for the first two days of life. Colostrum pasteurization is becoming more common in an effort to control the spread of coliform pathogens, *Mycoplasma* and Johne's disease. Extra care is needed to prevent the coagulation of the product and excessive loss of maternal immunoglobulins. If the calf will not nurse, esophageal feeders can be used. This equipment should be thoroughly washed with warm soapy water, rinsed, then disinfected and hung up to dry between uses. A plastic garbage bag could be thrown over it to protect it from environmental contamination from flies or feces.

Replacement Animals

In general, replacement heifers and bulls should be housed away from adult cattle and in spaces that are suited to their age, size, feed intake, and reproductive needs. There are five distinct groups of heifers: pre-weaning (0-2 months), weaned (3-8 months), pre-breeding (9-12 months), bred (13-22 months), and pre-fresh (23-24 months). Bull calves are typically sold at an early age, pre-weaning, or just after weaning unless they are kept as breeding stock. However, the information below applies to bull calves in regards to disease management.

Pre-Weaned

Young calves, pre-weaning, should be housed individually to minimize the risk of disease spread and to facilitate identification of illness. Calves should have free access to fresh water throughout the day and a calf starter should be made available by 3 days of age. Quality milk replacer or pasteurized whole milk should be offered twice a day to ensure adequate nutrition and growth. If milk is pasteurized, time and temperature of the batch should be monitored on a frequent basis to ensure proper destruction of organisms from the lactating cows. Pasteurized milk is an inexpensive source of feed for young calves if done properly. It can become the most expensive commodity on the farm if it is not properly pasteurized and organisms are allowed to infect the young calf.

Young calves are susceptible to a wide variety of diseases, many of which are zoonotic (E. coli, salmonellosis, cryptosporidiosis, leptosporosis, and rabies), so proper personal protective equipment such as gloves, coveralls, and boots, should be worn when feeding and handling neonatal calves.

Pre-weaned calves are the most susceptible age group on the farm and should be fed/handled before the older animals to minimize pathogen introduction. If this is not possible, proper disinfection needs to occur before preparing their milk and feeding them. Hands should be thoroughly washed and disposable gloves worn if possible. Coveralls or clothing and foot wear should be clean; free of organic matter (feces, urine, saliva, milk) from other animals. Even if you are just putting milk bottles into holders you should be clean from head to toe. Just when you do not plan to have to handle the animals, one may be reluctant to stand and drink or have an illness that needs to be investigated further. Due to the activity of young calves and their suckle reflex, minimal contamination on the feeder's clothes will expose the calf to disease causing organisms. It is important to plan ahead before dealing with this susceptible group. Even within the group of calves, working with the youngest animals first can help decrease the risk of disease spread. Milk bottles used to feed these animals should be removed after nursing and the nipples and bottle rinsed with water to remove all organic material, washed in warm water (150$_o$F) with mild detergent, rinsed, inverted and allowed to dry completely before the next feeding. Sanitization of the bottles may be necessary in an outbreak situation. Similar to the esophageal feeder, these clean bottles and nipples should be kept free from environmental contamination in between uses. Milk is an excellent nutrient source for bacterial and viral organisms and if calves are fed in buckets, the buckets should be rinsed after all the milk is consumed to remove the residue. It is good management to rinse each bucket and refill it with fresh, clean water until the next milk feeding. Similar recommendations apply to grain, as it can serve as a breeding ground for both bacteria and insects.

If the calf pen or hutch has solid walls, this will decrease the chance of direct and oral contact with another calf, decreasing the chance of disease spread. If hutches or pens are located outside, adequate shade and ventilation is necessary to avoid overheating and dehydration of the calf. Hutches have the additional benefit of minimizing the concentration of respiratory pathogens. If the calf is allowed to exit the hutch, it is essential to avoid direct contact with other calves or animals to minimize disease spread. This can be accomplished by fencing or tethers that prevent access of calves to one another or their excrement. Calf pens or hutches must be cleaned, sanitized and disinfected between introductions of new calves to minimize disease spread. The ground underneath the calf hutch has the potential to harbor pathogens; organic bedding should be removed and the ground/concrete/gravel remaining idle with sunlight exposure. Time of idleness will depend on the organism; bacterial, viral or protozoal pathogens differ in their environmental survivability, but two weeks is common. Some are able to be killed in dry environments rather quickly (BVD); others persist for longer times (cryptosporidium). Weather conditions and seasonality will affect the persistence of the organism. It is essential to determine the neonatal calf disease threat(s) and design protocols for calf hutch/pen management that targets the pathogen(s). Vaccination should not be a substitute or crutch for good hygiene practices. The “solution to pollution is dilution” and producers should be reminded of that in regards to this susceptible neonatal calf.

If calves are housed in pens with open sides, age cohorts become essential to minimizing disease spread. The risk of direct and aerosol disease spread is higher in this situation, so the area should be filled for a period of two weeks or less and then no additional animals added. This is based on the incubation period of the typical disease organisms that affect the neonatal calf. Longer than two weeks increases the susceptibility of the newly introduced animals to the pathogens in the environment. The same protocols for feeding apply here, but disease spread is a little more difficult to control due to aerosolization of pathogens.

It is at this life stage (less than 10 weeks) that calves should have their horn buds removed. Restraint is easier at this stage and the procedure, when done correctly, has minimal pain effects on the calf. Dehorning can be done with chemical treatments (calcium chloride injections and caustic sticks) and electrical dehorners, with the goal of interrupting blood flow to the developing horn. Cordless, electrical dehorners can be used at 1-3 weeks of age and take less than 10 seconds of application time if done properly. There is no blood to attract flies and institute larval development and subsequent disease as is the case in older animals during dehorning.

Heifer calves should have their supernumerary teats removed at this age as well. Again, restraint is easier and when done correctly, has minimal pain effects. The udder area should be clean, free of debris, and scrubbed with a surgical scrub prior to removal. During removal, gently pull the extra teat away from the udder and cut at an angle from the calf’s head to tail with a pair of sterilized surgical scissors. The scissors should be cleaned and disinfected after each use to minimize the risk of infection or disease transmission. Spray the wound with iodine or another antiseptic and be prepared to cauterize or tie off any blood vessels; although bleeding is generally minimal at this age.

<u>Weaned</u>

Once calves are weaned and moved into group housing, considerations should be given regarding animal and group size, and health status of the animal. This is a stressful time for animals due to change in social structure, feeding and housing. First groupings of animals should be up to 6 head and given plenty of space; 25-30 sq ft per head is recommended (MWPS 2000). This will help them adjust socially to their new environment, feeding and watering style. Less stress means less cortisol release leading to a stronger immune system that is better able to deal with commingling; all very important concepts in disease management. As animals adjust to their new environment, group sizes can be increased. While not scientifically proven, it has been suggested increasing group in increments of two's will help improve the social structure of pen mates and reduce stress; the "buddy system" per se.

Proper ventilation, without drafts, is essential to keep aerosolized pathogens from accumulating. Clean, dry bedding, shade, fresh feed and water are still essential to keep the calves' immune system functional so that it is able to fight disease challenges.

Feed and watering will change to a group setting rather than individual buckets. The same basic hygiene principles apply here as above. These animals should be fed before older animals and equipment used to deliver their feed should be clean; free of organic matter (feces, urine, saliva, milk) from other animals. Waterers have a greater potential of contamination with multiple animals in the same enclosed area, so they should be monitored daily for functionality and cleaned weekly or whenever organic debris begins to accumulate.

Vaccinations are essential at this time because maternal antibody has waned and the calf could be exposed to novel pathogens in a group setting. Establishing a protocol with the herd veterinarian based on endemic diseases, future breeding and transportation needs are essential to help develop a healthy heifer.

Pre-Breeding

The same basic hygiene principles regarding feeding and watering apply here as above. These animals should be fed before older animals, but after bred heifers. (Bred heifers have a higher risk of disease exposure due to their pregnancy status and the risk of BVD persistently infected animals, for example). Equipment used to deliver their feed should be clean; free of organic matter (feces, urine, saliva, milk) from other animals. Waterers have a greater potential of contamination with multiple animals in the same enclosed area, so they should be monitored daily for functionality and cleaned weekly or whenever organic debris begins to accumulate.

This group of animals will need to be vaccinated and boostered for the diseases that can be a challenge during pregnancy, so their immune system is ready to adjust to carrying a calf for nine months.

Disease risks associated with breeding vary depending on the type of reproductive service used. In natural service, it is essential that the herd bull(s) have a breeding soundness exam that includes motility testing and staining, palpation of the seminal vesicles, testes and examination of the penis for abnormalities. A full range of herd vaccinations 30 days prior to entry, and diagnostic procedures for both venereal and systemic disease pathogens, including BVD, according to the herd veterinarian's recommendations are good management techniques to minimize disease introduction by the herd bull(s). When using artificial insemination, acquire semen from a reputable source that tests their bulls for venereal diseases and screens for genetic abnormalities. Upon insemination, basic hygiene principles apply. Hands should be thoroughly washed and disposable gloves worn if possible. Coveralls or clothing and foot wear should be clean; free of organic matter (feces, urine, saliva, milk) from other animals so that the pipette does not get contaminated. There are specific management protocols relating to semen straw storage and thawing, but in regards to disease management, keeping the pipette clean is essential to minimize pathogen entry into the vagina. All barriers (gloves, rectal sleeves) should be disposed of after inseminating each animal, again to minimize cross-contamination. Similar precautions should be taken when collecting and transplanting embryos.

Bred

Due to their pregnancy status, this group of animals is more susceptible to disease than the pre-breeding animals, even though they are older. Due to the in-utero calf, their immune system is compromised, so every effort must be made to limit their disease exposure. Not only is the bred heifer less able to fend off infection, she carries a naïve calf that could succumb and abort, become a stillborn, a weak calf or congenitally infected. In a ranking process, they would be considered more at risk for disease than pre-breeding animals yet not as susceptible as pre-weaning or weaned calves.

The same basic hygiene principles regarding feeding and watering apply here as above. These animals should be fed before older animals and before pre-breeding animals due to the different “at risk” conditions. Equipment used to deliver their feed would preferably be designated for feed usage only; otherwise it should be thoroughly cleaned and disinfected; free of organic matter (feces, urine, saliva, milk) from other animals. This rule also applies to the equipment that assists in the production of rations such as skid steers and front end loaders. Waterers have a greater potential of contamination with multiple animals in the same enclosed area, so they should be monitored daily for functionality and cleaned weekly or whenever organic debris begins to accumulate.

Animals should be monitored daily for signs of illness and/or abortion. If an animal should abort, promptly remove her and her fetus along with all other birthing material. Based on the risk of zoonotic diseases causing abortion in cattle (brucellosis, leptospirosis, listeriosis, salmonellosis), proper personal protective equipment especially gloves, should be worn when handling the fetus and parturient material and fluids. The area should be cleaned and disinfected to minimize the risk of an infectious agent exposing other bred animals. Heifers should be isolated from other animals and minimally exposed to older, lactating cows. The fetus, depending on the state of degradation, may need to be promptly submitted for diagnostics, based on the recommendations of the herd veterinarian. The cow/heifer may or may not come into her milk, depending on the stage of her gestation when she aborted. If she is to be milked, she should be treated as an isolation case; milked last and minimize contact with other animals. Ideally she should be housed alone without direct contact to other cows/heifers. Housing her with hospital cows could predispose her and others to continual infection, depending on what the abortion resulted from (infectious versus genetic/toxic ingestion).

Pre-Fresh

Within 3-4 weeks of their projected due date, heifers/cows should be moved to an area where they can be monitored multiple times a day. Their nutrient needs are changing, as is their dry matter intake. They should be fed on a plane of nutrition targeted to their needs and the needs of that near-term calf in order to produce high quality colostrum. Grouping heifers with multiparous cows raises a few concerns, although most facilities are not set up to do it any other way. Things to consider in regards to housing related disease risk are:

Are the heifers from the same source as the adult cattle? If so, then they are not considered “newly introduced”. However, if they are recently purchased or returning from a professional heifer grower, then isolation to prevent disease introduction would be necessary for the heifer, her unborn calf and the pregnant multiparous cows on the home facility. See section on newly introduced animals for recommendations to prevent disease entry and spread.

What is the social difference between a heifer and cow? Heifers are typically submissive to older individuals. Movement into group housing with mature cows will result in time spent establishing social dominance. This can cause immunosuppressive stress through animal to animal bullying and reduced dry matter intake. This can predispose them to disease during this crucial pre-fresh period.

What is the prevalence of various diseases in the source adult herd? If the farm has an eradication plan in place for specific cattle diseases, the risk is too high to group pre-fresh heifers with multiparous cows. There are certain diseases in adult cattle that can be easily spread through excrement to newborn calves. If a heifer calves before being moved to a clean maternity area, that neonatal calf is now in a high risk area for disease exposure. Endemic disease prevalence is an item that the herd veterinarian has the expertise to manage. If there are no diseases of concern, which is rare on most dairy operations, home raised heifers should be at relatively low risk for pathogen spread from the adult animals.

The same basic hygiene principles regarding feeding and watering apply here as above. These animals should be fed before older animals due to their susceptibility to disease. Equipment used to deliver their feed should be clean; free of organic matter (feces, urine, saliva, milk) from other animals. Waterers have a greater potential of contamination with multiple animals in the same enclosed area, so they should be monitored daily for functionality and cleaned weekly or whenever organic debris begins to accumulate.

Animals should be monitored daily for signs of illness and/or abortion. Once again if an animal should abort, promptly remove her and her fetus along with all other birthing material. Proper personal protective equipment, especially gloves, should be worn when handling the fetus and parturient materials and fluids, again due to the risk of zoonotic disease. The same information stated above in bred animals applies here, although heifers often come into their milk at this stage of gestation and should be milked as an isolation case.

These animals should be housed in a pen where they can be monitored frequently throughout the day. Manure management is essential as animals could calve in this area and disease exposure to the newborn calf must be minimized. Once signs of calving are present, heifers/cows should be moved to an individual calving pen that is clean, dry, and draft free. See "maternity pen" section for specific recommendations.

New Introductions

The most certain way to prevent introducing a new disease would be to prevent introducing new animals to the herd. This is not feasible for many dairy facilities, so accepted risk practices need to be established. Biological risk of transmission of pathogens such as *S. aureus, M. bovis, Mycobacterium avium paratuberculosis*, BVDV and *Salmonella* spp. can be minimized by limiting the frequency and number of new introductions as much as possible.

Purchases should be limited to a minimal number of sources, preferably with a known and trusted herd health program. A complete herd health history should be obtained prior to introducing new animals if at all possible. It is not unreasonable to request copies of bulk tank samples, somatic cell count, DHIA reports, and vaccinations, illness and treatments records of purchased animals. Dairy producers need to establish the level of disease risk they are willing to accept and the level of biosecurity they are willing to pay for.

Testing for diseases of interest should be considered as well. Many additional factors should be evaluated in this decision, including the risk of disease introduction by this animal, potential consequences associated with disease introduction, how the disease is transmitted, and whether there are other effective ways to manage or control the disease (vaccination or treatment, for example). Characteristics of the test should also be considered, such as sensitivity, specificity, cost, convenience and potential risks associated with testing, and time required obtaining meaningful results. Results must always be interpreted in light of other evidence. A positive test result should always be of concern and could justify additional testing (for more definitive diagnosis) or termination of the sale. A negative test result does not guarantee freedom from disease and should not be accepted as the sole determinant of risk. The test sensitivity, clinical appearance of the animal, history, and status of the herd of origin must all be used to provide meaning to a negative test result and limit the risk posed by a newly introduced animal.

There are inherent risks associated with purchasing animals of various ages. This should be recognized and used to guide purchase decisions. For example, purchasing young animals has a greater risk of introducing calf hood diseases such as scours and respiratory diseases. Animals that have mated previously could introduce reproductive diseases. Older animals are also more likely to have contracted chronic or latent infections, particularly those that are not restricted to being acquired during calf hood. Susceptibility and/or clinical signs can also change with age. However, older animals that have developed a tolerance to a disease may not show clinical signs but could be a carrier. These issues should be considered when deciding on testing protocols and what age group of animals to purchase.

It is recommended that animals that are newly acquired or reintroduced after an absence be quarantined for a minimum of 21 days, some recommend 30 to 45 days. This will allow adequate time for clinical signs to develop if the animal is incubating an acute infection. However, chronic or latent infections may not show symptoms for years, if ever. An additional benefit of isolation is to allow sufficient time to obtain negative test results if pre-entry testing procedures are performed. The isolation facility should be capable of preventing contact with **all** other animals including those in the destination farm as well as those in neighboring operations and wildlife. The isolation must protect from all of the potential routes of transmission, and receive the same BRM scrutiny as all other areas of the operation. The isolation area should be cleaned and disinfected and ideally sit empty for some time between uses.

When introducing animals, doing so in groups that can be housed, fed, milked last and treated together will help spread out the costs of the special handling. People are more apt to follow protocols for a whole group of animals rather than one animal that can get lost in the shuffle. Continual introductions to an established group of animals results in social stress and repeated exposure to new pathogens. Purchasers should vaccinate newly acquired animals, utilizing a program that matches the home herd to the greatest extent possible (read and follow the recommendations of the vaccine manufacturer). Preferably this should occur prior to delivery on the premises.

Animals Returning to the Farm

Movement of animals on and off a dairy operation can introduce disease. Therefore, animal traffic should be limited to the minimum amount necessary. Delivery/load-out areas should be located at the perimeter of the property and should be cleaned and disinfected thoroughly after new cattle arrive. All trucks and trailers used to transport animals should be cleaned and disinfected inside and out after each use because they often travel to areas where pathogens are abundant in the environment. Accumulation of manure, feed and bedding is a perfect medium for organism survival and multiplication.

When animals are taken off of the operation and then return (fairs, shows, veterinary clinic, and embryo transfer facilities) they should be handled as a new introduction. Additional measures should also be taken during their time away to limit their contact with other animals. This includes prohibiting sharing of trailers, stalls, feed or water with animals from other operations. Other items to consider include: halters and lead ropes, grooming supplies, feed and water containers, reproductive equipment (artificial vaginas for semen collection, artificial insemination pipettes, uterine pipettes, etc.), needles and syringes, among others. These items should not be shared; otherwise they need to be properly cleaned and sterilized between animals. Diligent efforts should be made to prevent fecal contamination of feed, water or the immediate environment by other animals. Direct contact with other animals should be minimized and reproductive activity should be prohibited. People contact should also be minimized. If at a fair or show do not allow the public to feed your animals.

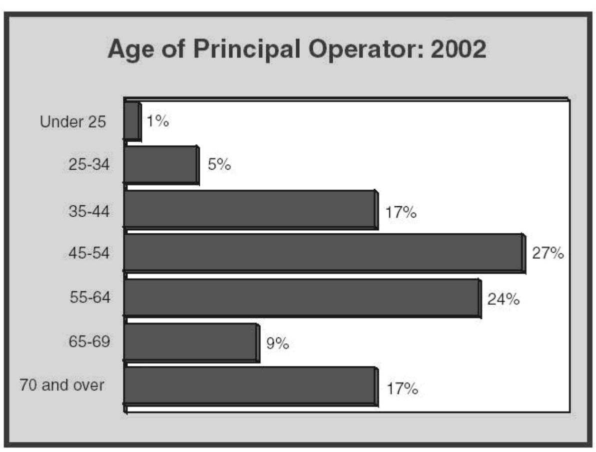
Human Traffic on the Dairy Farm

Foot traffic also poses a significant risk of pathogen introduction and spread on a dairy facility (such as *S. aureus, Mycobacterium avium paratuberculosis* (Johne's), BVD and *Salmonella* spp.). People walking through a farm include employees, neighboring property owners, sales and service personnel, veterinarians, hunters, hikers and other visitors. In order to keep track of who comes and goes, anyone who does not live on the facility should be required to sign a visitor's log book and instructed on what areas are acceptable or unacceptable for foot traffic. Restricted areas need to have clearly posted signs so as to remind visitors not to enter. It is important to ask visitors about prior contact with animals on other operations, and ask those at high risk of transmitting disease to take additional precautions (shower in and change clothes or return at another time). Regardless, restricted areas should be delineated and animal contact should be minimized.

Producers should also consider requiring all visitors to wear clean coveralls and overboots. Providing clean coveralls for visitors will cover any "outside" organic debris on the visitors clothing and provide a barrier to disease introduction. The coveralls will also allow all organic material that is obtained on the farm during the visit to remain on that farm and prevent carrying it to another facility or into the home of the visitor. This can help protect the visitor and their family against potential zoonotic diseases. Disposable plastic overboots can be provided rather inexpensively (less than $1.00 per pair) and provide the additional benefit of protecting visitors shoes from manure and soil/mud; again a potential zoonotic disease concern alleviated. Another option is to provide a foot bath at the main entrance with a requirement that all visitors disinfect their footwear. However, there are limitations to the effectiveness of human foot baths. All gross debris must be cleaned off first and the disinfectant solution must be used under appropriate conditions (proper concentration, proper temperature, free of organic debris, frequent maintenance, etc.). A footbath that does not meet these conditions may in fact create a false sense of security while providing little or no protection.

Zoonotic Disease and Health Concerns of Employees

The chart below is from the 2002 Census of Agriculture and shows the distribution of the ages of the principal operator on today's farms.



The average age of today's farmer is 55.3. As people age, their reflexes and immune systems decline. They aren't as able to react to a fractious animal or recover from injury or illness. Considerations need to be made for those older, as well as the very young, at risk individuals. While there is no definition of what categorizes a person as older or elderly, it is known that the immune system does not function as efficiently in older adults as it does in younger people. The body becomes less able to fight infection and the central nervous system becomes less sensitive to immune signals, making the immune system function less efficiently. For example, more than 20% of adults over age 65 that had a serious bacterial infection lacked a fever response (Burns 2001). Illness may be more difficult to fight in this population, making prevention even more important. This age group often works with adult cattle and young calves and there are many zoonotic diseases that this population should be aware of. Listeriosis, brucellosis, salmonellosis, Q fever, tularemia, botulism, staphylococcus and streptococcus infections, *E. coli*, salmonellosis, cryptosporidiosis, leptospirosis, ringworm, and the most serious- rabies are all diseases that adult cattle could pass to the dairy workers and/or their families. There are ways to prevent such infections, such as wearing personal protective equipment (gloves, masks, rectal sleeves, waterproof gear, coveralls, boots and others) in situations that may predispose them to exposure. Calvings, abortions, rectal or vaginal palpation, artificial insemination, milking infected animals, passing esophageal tubes or balling gloves, doing an oral exam, necropsies, and handling vaccines or antimicrobials are situations that may cause abrasion of the dairy producer’s skin or expose their mucous membranes and they should protect themselves.

Other at-risk clients and their employees may include: children under the age of five, pregnant women, and immune compromised individuals. While the most profound immune suppression is caused by HIV/AIDS, other diseases and conditions that can compromise the immune system include tuberculosis, bone marrow or organ transplants, radiation, chemotherapy or chronic corticosteroid therapy, chronic renal failure, or implanted medical devices (pacemakers, defibrillators, artificial heart valves, artificial knee or hip joints). Persons with diabetes, alcoholism with liver cirrhosis, malnutrition or autoimmune diseases, splenectomy patients, and those on long-term hemodialysis also have compromised immune systems. It is important to note that some of these conditions or diseases may have a social stigma, making it difficult for a client or their employees to share their personal health information. This again makes it vital for veterinarians to educate their clients and their employees about zoonotic diseases.

Children are the future of farming and are a part of many dairy operations in the United States. It is important to understand what our young farmers may be at risk for. Children under the age of five have naïve immune systems, just like neonatal calves. There are many pathogens on a farm, some of which are zoonotic, so educating children and their parents about their risks and how to protect them is essential. One of the tasks on a dairy farm that often falls to the responsibility of young children is calf chores. Feeding, watering, and bedding the calves is something kids are able to do without much supervision and gives them a sense of pride in helping out. It is important to remember what the *E. coli* example in the beginning of this presentation illustrated- children can succumb to disease if exposed. Children who feed neonatal calves should be taught proper hygiene. Things like washing hands before and after feeding the calves, wearing gloves if possible while feeding, and never eating or playing around the calf hutches. They should have designated calf chore clothing and it should be taken off immediately after taking caring for the calves and put in a proper area so younger siblings do not contact it. Over time, children’s immunity will build up to many pathogens, but some will always remain a zoonotic disease threat (*E. coli*, salmonellosis, cryptosporidiosis, leptosporosis, ringworm, and the most serious- rabies). Just like the petting zoo example, appropriate signage, hand washing stations for younger people and education about the risks are vital to keeping kids safe from disease.

Regardless of age, certain biological agents used for animals can pose a risk to those handling them. Oxytocin and prostaglandins have detrimental effects on pregnancy and should never be handled by pregnant women. Other products may have toxic potential if accidentally injected or absorbed via mucous membranes (eg. the sedative detomidine, brucellosis vaccine). These items should be properly identified and precautions should be taken when handling these agents, such as:

- Storing products in a cabinet or refrigerator designed for that purpose. Food for human consumption should never be stored with biologicals.
- Injection needle caps should never be removed by grasping with the mouth.
- Hands should be washed after handling any biologicals.

Proper and frequent hand washing is the best way to prevent many zoonotic diseases. The following hand washing technique is recommended:

- Wet hands;
- Apply soap and rub hands together for at least 15 seconds;
- Rinse with water; and then
- Dry hands with a single-use, disposable towel (using a multi-use towel can spread disease between individuals).

Hands should be washed immediately after handling sick animals, after coming in contact with feces or urine from animals, after using the restroom, and prior to eating to minimize the risk of zoonotic disease. Practicing and teaching these techniques can help protect the veterinarian, staff, and clients from unnecessary exposure.

Another consideration on today's dairy farm is the immigrant worker. Some farms sponsor immigrants for 6 month and 1 year internship experiences, while others employ permanent immigrant workers. Diseases prevalent in some of these countries could predispose these workers to infection with a zoonotic disease. The communication barrier may increase their risk of exposure, so working with knowledgeable translators and ensuring proper medical care will keep this at risk population safe and continue their employment on the farm.

Studies show that veterinarians are the most knowledgeable and the expected purveyors of information on zoonotic disease. Studies also show that immune compromised individuals are not offered adequate information about zoonoses prevention, either from their physicians or veterinarians and may not be as comfortable discussing their immune status with their veterinarian. Physicians and veterinarians alike must share in the responsibility of education about zoonotic disease.

While the possibility of exposure and transmission of zoonotic diseases from animals to people cannot be totally eliminated, it can be minimized. By providing immune compromised clients with correct and up to date zoonotic information, we can encourage them to keep their animals healthy and minimize exposure. This can be accomplished through:

- Making producers aware that information is available to them if they or family members are immune compromised,
    - Through conversations on farm, clinic newsletters, extension or outreach to local community organizations;
- Making dairy producers aware that immune status can be affected by many conditions;
- Speaking with immune compromised clients regarding animal handling guidelines and recommendations;
- Providing a handout/brochure on zoonoses information with web links for further information.

Routes of Transmission

Pathogenic agents can be spread from animal to animal, or animal to human, through a variety of transmission routes. Animals or humans can acquire disease causing agents through inhalation or aerosolization, oral consumption, direct contact, via fomites or vectors. Dairy cattle are often exposed to a variety of pathogens due to the environment in which they are housed and milked. Many disease agents can survive for extended periods of time in soil or other organic material. While not a route of transmission, environmental contamination must always be taken into consideration. We will discuss each of these routes and recommend control strategies to manage disease risk in the coming sections.

Aerosol

The ability of pathogens to survive and be transmitted in the air varies by organism as well as other factors such as season, temperature, humidity and wind speed. However, the greater the distance of separation between a carrier and a susceptible animal the less likely transmission will occur. Direct contact between an infectious and susceptible animal will result in exposure, while pathogen concentration in the air decreases exponentially with distance. Therefore, increasing distance between wildlife, animals from other operations, and newly introduced animals should minimize exposure by the aerosol route.

Appropriate ventilation is extremely important in reducing airborne pathogen transmission. This becomes most important in the calf housing areas. Whether calves are housed in individual hutches, a greenhouse barn, or a confinement facility, adequate ventilation, moisture control, and temperature regulation are essential for healthy animals. There are recommended guidelines regarding the number of air exchanges in confinement facilities depending on the buildings length, width, height, desired temperature, type of ventilation system and the number of animals. It is recommended to maintain room air relative humidity at 50-75% to minimize condensation, dust and airborne bacteria. (MWPS 1985)

Adult dairy cattle housed indoors also require appropriate ventilation to minimize airborne disease exposure year round and to minimize heat stress during certain times of the year. Times of congregation, such as moving cattle to the holding pen prior to milking, within the parlor, and around feed bunks and waterers if cattle are housed outdoors, can influence the airborne pathogen load. Cattle should be moved slowly so as not to increase respiratory rate which could induce coughing and expiration of pathogens from infected animals. Excitement and stress should be held to a minimum so as to minimize airborne disease transmission.

Extension services, agricultural engineers and Midwest Plan Service have specific information available for ventilation needs for various types of dairy facilities.

Oral

Oral transmission can occur through consumption of contaminated feed, water, or the environment that cattle may contact with their mouth. Items such as equipment, feed bunks, water troughs, fencing and other objects that they can lick; contaminated mineral, sodium bicarbonate, and salt feeders; oral drenching equipment, esophageal tubes, and numerous other objects found on a dairy operation can transmit pathogens orally.

Milk/Colostrum

The first feedstuff consumed by a calf should be colostrum. Milk and colostrum are very effective means of transmitting disease organisms (*S. aureus*, Johne's disease, *M. bovis*, BVD and *Salmonella* spp.) from dam to calf and from the environment to calf (via soiled or fecalcontaminated teats and udder). One might consider the optimum BRM plan to include testing cows for diseases of concern (Johne's, salmonellosis, bovine leukosis virus and others), and using colostrum from test negative animals. Single source, dam to calf colostrum is generally considered the preferred feed source for neonatal calves. An alternative source is sometimes required when a dam is agalactic, has severe mastitis in multiple quarters, or is otherwise unable to provide an adequate source of colostrum for her calf. In this case, colostrum should be provided from an older, healthy cow from the same herd. Colostrum from such animals should be collected as aseptically as possible and can be frozen for up to one year without significant deterioration in quality. To store colostrum, use 1 gallon zippered lock baggies. Fill it ¾ full with colostrum and lay it flat to freeze. Each bag should be labeled with the cow's identification number, collection date and any other pertinent information. That way, should an animal test positive for an infectious disease, her colostrum can be removed from the supply. Do not stack colostrum bags in the freezer until they are frozen. Condensation accumulates and the bags will freeze together if stacked too early in the freezing process. The one gallon bags allow for ease of thawing due to their large surface area that can contact warm water in a bucket. The bag also stores enough colostrum for the first feeding to a newborn calf.

Pasteurization of colostrum is becoming more common so as to decrease the risk of pathogen spread to newborn calves. The benefit of minimizing the risk of disease spread versus the destruction of proteins, specifically immune globulins, needs to be weighed for each herd. Research is ongoing for ideal time and temperature.

Post colostrum feeding, calves should then be fed pasteurized whole milk or high quality milk replacer to prevent transmission of diseases. If milk is pasteurized, time and temperature of the batch should be monitored on a frequent basis to ensure proper destruction of organisms from the lactating cows. Milk replacer should be stored in an air-tight container so as to keep out environmental contaminants and to minimize risk of oral spread of disease upon next feeding. The containers used to feed milk (see fomites) can be an excellent source of oral contamination (S*. aureus, M. avium paratuberculosis, Salmonella* spp.) if not rinsed and cleaned properly between uses.

Feedstuffs

Control of the feed sources and quality is just as important for the remainder of the herd. All feeds on a dairy should be evaluated for their risk of introducing and/or transmitting disease. This includes harvested feeds (silage, hay and grain), purchased protein sources, mineral mixes, and other supplements. Feeds purchased from other sources should be accompanied by an acceptable quality assurance program and documentation. This should verify that reasonable measures have been taken to protect the feed from contamination with potential disease-causing material, including ruminant derived protein. If a contamination is suspected, a representative sample of the feed should be collected and frozen for diagnostics.

The best feed can become a threat if not handled and stored correctly. This typically means preventing access and contamination from **any animals,** including wildlife, birds, vermin and scavengers, as well as dogs, cats, cattle and other livestock which may urinate, defecate or otherwise introduce disease. For certain feedstuffs, like silage and grain, it may also mean proper protection from weather (to prevent spoilage and mycotoxin development), as well as special efforts in ensiling and/or processing to ensure appropriate conditions (anaerobic, low pH, etc.) are achieved to protect the feed from listeriosis, clostridium, and mycotoxin proliferation. During harvest, it is essential that wildlife carcasses are not ensiled because they carry the risk of contaminating the feed with botulinum toxin. Spilled feeds should be frequently cleaned up and disposed of, particularly adjacent to storage or feeding areas. Spilled feed attracts rodents, wildlife, fosters spoilage, and serves as breeding ground for other pests. In most cases, stored dry commodities should be used in a first-in, first-out manner, and new feed should not be added to or poured on top of older feed. Similar diligence is needed in utilizing the feed. For silage stored in trenches, the face must be maintained appropriately by removing an adequate amount each day to prevent spoilage (this is generally recommended to be 6-12 inches off of the entire face each day; however, this will vary with weather conditions).

Feed bunk and manger management is essential to ensure good quality feed for optimal dry matter intake. Adequate nutrition is required for an animal to remain healthy. In order to meet the high intake demands of lactating animals, feed should be made available throughout the day. Therefore a large amount of feed is delivered once or twice a day. It is important in these situations to push up feed frequently to encourage consumption and remove old feed, especially if it has been contaminated. Piling new feed on top of old presents an ideal environment for proliferation of spoilage and disease organisms during hot weather. Scraping feed bunks and mangers to remove all old feed should be done on a regular basis to ensure the spoiled feed does not get consumed or contaminates fresh feed piled on top. From a disease standpoint, if feed is allowed to spoil, it serves as a great nutrient source for microorganisms to proliferate. Organisms, such as *Listeria monocytogenes* and *Clostridium perfringens*, and mycotoxins can grow in old, spoiled feed and expose the cows upon consumption. Accumulation of old feed also serves as a breeding ground for flies and other pests which can spread disease (discussed more in-depth in vector section). Concrete feed bunks deteriorate over time and cracks and holes serve as an incubator of organisms if they get packed with feed. Things such as plastic bunk liners, polyethylene coating, and ceramic tiles can be used over the concrete to keep the surface smooth. It minimizes spoilage and exposure to oral consumption of disease pathogens.

Often feed is offered to cattle on the ground at the same level where people walk and drive. At no time should anyone walk or drive through feed. Feces, urine and saliva can subsequently contaminate the feed and cause oral consumption of disease causing organisms. Man-passes (people-passes) could be used so that personnel are able to enter the cow's pen without climbing through the feed bunk or over fences. Again, the possibility of wildlife or rodents introducing disease must be recognized, and access to feed bunks or stored feed areas should be minimized and eliminated if possible.

For animals on pasture, efforts to protect them from oral consumption of disease organisms include avoiding fertilization with high risk materials (non-composted manure, possibly poultry litter), frequently dragging the fields to break up fecal pats in drier climates (organisms die more rapidly when exposed to heat, sunlight and wind), and avoiding overgrazing, which forces animals to graze closer to the ground and nearer to fecal pats. Cattle should be kept away from pastures fertilized with high risk materials for as long as possible.

Supplemental hay feeding can present a unique challenge for disease control. Use of hay rings or similar feeding methods congregates the animals which can lead to a contaminated environment. Dispersing the hay (scattering flakes or unrolling large round bales) reduces this, but often leads to contamination of the hay when animals lay on it or soil it. Regardless of which method is used, frequent changing of the feeding area, appropriate grouping of age cohorts and minimized stocking density will be beneficial. Similar principles apply to wooden feed bunks- frequent movement and minimal feed wastage are ideal to avoid spoilage. These should be cleaned out frequently to avoid feed buildup and bunk liners used to avoid accumulation in the cracks.

Water

Water consumption is necessary for life and milk production. Milk is composed of 86% water, so offering a fresh, clean source is essential to milk production. Animals fed in confinement or tie-stall/stanchion barns should have water available in troughs or drinking cups throughout the day. Waterers can serve as a risk factor for disease if not maintained and cleaned properly. Waterers should be monitored daily for functionality and cleaned when organic debris begins to accumulate. In trough type automatic waterers, a rail should be installed two feet above the top rim of the waterer. This will minimize cows from standing or defecating in the trough while allowing their heads to enter freely and consume water. Young calves should be offered fresh water throughout the day and a rail can be installed at 18 inches (or lower for younger calves) above their automatic water trough to prevent entry and defecation. Individual water buckets should be cleaned as described in the fomite section to avoid accumulation of organic debris.

Natural sources (creek, pond or cistern) are often used in pasture situations because of convenience and reduced expense. Generally speaking, troughs are preferred because of quality control and less wildlife/other animal contamination. Natural water sources are at risk from contamination by wildlife, other livestock operations (leptospirosis, among other diseases) and other natural threats (blue-green algae, for example). The source should be protected as much as possible and monitored for problems. Regardless of the water source, dairy producers should consider testing water quality every six months, and more often if there is a problem. Monitoring coliform counts, nitrates and nitrites, sediment, hardness, and other minerals can be helpful to prevent disease and maximize milk production.

If cattle drink directly from ponds, producers should consider fencing the pond off and providing limited access. This access area can then be protected by concrete or large rock to prevent soil erosion into the pond, and limit runoff into the water. By preventing animals from entering the pond, fecal and urine contamination is greatly reduced, as is the risk of cows getting mastitis. Similar measures can be taken to prevent contaminating streams, although it may be harder, due to the length of the stream. Streams pose an additional disease threat, due to the potential contamination from upstream. Producers should strongly consider restricting access of cattle to streams.

Manure and Waste Management

Because many of the diseases contracted through the oral route (such as salmonellosis, campylobacteriosis and giardiasis) originate from fecal contamination, waste management is vitally important in controlling these pathogens. Due to their intake, dairy animals deposit between 2.0 to 2.4 cubic feet (115 pounds; 14 gallons) of manure a day (Environmental Protection Agency, Purdue University, 2004). This requires frequent waste removal, once to several times per day depending on the housing, weather conditions (hot weather induces drinking and more frequent urination) and animal density. It should then be transported to a designated storage or disposal area, out of contact with animals. This should be done with **designated equipment**. This equipment should not be used for other purposes, such as feed delivery, bedding, crop handling, etc.

For larger operations, requirements for waste handling are usually determined by state or federal environmental regulations. These regulate when and where waste can be spread to minimize environmental impact, as well as storage and transportation. Our focus is only on possible disease transmission; local, state and federal regulations will provide much more specific guidelines, and should be understood and followed.

If manure is to be stored, it should be kept in a well constructed lagoon, with adequate capacity to handle large precipitation without overflow. The location should be such that, should an overflow occur, it would not expose animals to discharge. If this is not possible, the most susceptible animals should be protected from exposure. Composting is considered by some to be a beneficial and viable method of handling manure. The advantages include a great reduction in volume and water content, and a significant reduction in pathogen levels. Disadvantages include the time required for completion of the process, the equipment and labor demands, and loss of nutrients. If waste is not composted, producers should be cautious in what locations and at what times manure is applied.

Cropland can generally be considered a minimal risk of sustaining pathogens if the waste is applied early in the growing season. However, for some persistent pathogens like *M. avium* subspecies *paratuberculosis* (Johne's), as well as protozoal oocysts (such as *Eimeria* spp.)

and helminth eggs, a single growing season is not sufficient to eliminate infectivity. Pastures are more of a risk, because there is no further processing to kill the organisms (like fermenting silage, drying hay, etc.). The safest recommendation would be to not spread manure on pastures in which susceptible animals would be placed (this of course will vary by operation, what animals are present, and what diseases are of concern). Similar or even greater cautions should be exercised in accepting manure or organic waste onto the farm from another source. Producers must recognize that they may be unwittingly permitting exposure of their animals to waste from other farms by streams and waterways or direct runoff. Such exposure may be transient (such as following a hard rain), but no less significant. A thorough examination of the operation's perimeter is required to assess where such points of access may occur and how they can be controlled.

The survival of pathogens within manure depends on a variety of factors including sunlight, drying, freezing/thawing cycles, high temperature, high/low pH, exposure to oxygen, ammonia concentration numbers, types of pathogen present and the adsorption of the pathogen to soil. Generally speaking, the risk of spreading disease will be lowered by exposing the waste material to environmental conditions. The most important means of accomplishing this is to adequately disperse the material. Dragging dry lots and pastures to break up and disperse fecal pats is an effective practice in drier climates. But similar to spreading manure for fertilizer, adequate time should be permitted between distributing the manure and returning animals to the lot or pasture. This ensures that the organisms are exposed to the damaging environmental conditions listed above.

Fecal Contamination from Other Species

Feces from other species can also serve to transmit disease to cattle. While it is virtually impossible to exclude wildlife from a pasture, every effort should be made to prevent access of animals to stored feed and feeding areas. Birds and vermin are quite effective at transmitting disease and are common in feed storage areas, confinement facilities and barns. Producers should recognize that even domestic animals pose risks because dogs, cats, goats, sheep and horses can all introduce disease to cattle.

Direct Contact

Direct contact requires the presence of an agent or organism in the environment or within an infected animal. A susceptible animal becomes exposed when the agent directly touches open wounds, mucous membranes, or the skin through saliva, nose-to-nose contact, rubbing, or biting. Neonatal calves should be managed in such a way to limit methods of direct contact, either with their dams or cohorts, to minimize disease risk. See the replacement section in herd characteristics for specific details. One of the most important efforts to reduce transmission via direct contact in adult cows is the isolation of sick or newly introduced animals. Ideally, a dedicated area or pen for isolation and separate milking facilities will help decrease the risk of diseases through direct contact. At the minimum, a dedicated pen within the operation is mandatory. Animals should be housed in this pen until they clear testing procedures or have had sufficient enough time to allow a disease pathogen to manifest itself. Additionally, incoming animals should be fed last, treated last, and milked last and all equipment should be cleaned and disinfected afterwards (see Fomite transmission for specific details on managing equipment).

Unfortunately, not all infected animals show signs of disease. In order to minimize transmission from carrier animals, fence line contact should be limited, both to animals from other operations (neighboring farms) and also to animals from different production groups on the same operation. Additionally, stocking density should be kept at the lowest acceptable level to minimize animal stress.

Fomites play a major role in transmission of direct contact diseases. It is imperative that producers recognize that virtually anything that contacts an infected animal then a susceptible animal can transmit that infection.

Reproductive

For the purposes of this document, reproductive transmission will encompass those diseases spread through venereal and in-utero routes. Venereal transmission, a type of direct contact, is the spread of pathogenic agents from animal-to-animal through coitus. In-utero transmission, another type of direct contact, is the spread of pathogenic agents from dam to offspring during gestation. Vaccination programs can be put in place for some of these reproductive diseases, but should only serve as an addition to proper BRM measures.

Disease risks associated with coitus vary depending on the type of reproductive service. See page 22 for management recommendations related to reproduction.

Vertical or in-utero transmission often involves a chronically infected dam; however, it may also relate to exposure of the dam during a critical stage of gestation. Test and cull strategies should be considered for certain vertically transmitted diseases. While whole-herd testing may be cost prohibitive, producers should be encouraged to test suspect animals, such as repeat or “hard” breeders, cows that show erratic estrous cycles, and animals that abort. Testing the dam and offspring of cows that are diagnosed with a disease that can be transmitted vertically (BLV, BVD, neospora among others) should also be considered. This demands maintenance of complete and current records to facilitate identifying dams and offspring of affected animals.

Additional control measures relate to protection of the dam at critical stages of pregnancy. This varies by pathogen and generally necessitates the classification of pregnant animals as a susceptible population on dairy operations.

Fomites

Virtually any inanimate object can serve as a fomite and carry a pathogen from one susceptible animal to another. Fomite transmission often involves a secondary route of transmission such as oral or direct contact for the pathogen to enter the host. Humans often play a principle role in facilitating fomite exposure, which is referred to as iatrogenic (see below). Therefore, in order to have a successful BRM plan for the all routes of transmission, it is vitally important that all potential fomites be recognized and handled appropriately.

There are many fomites on a dairy farm in each of the life stages listed above. We will start by discussing lactating animals and the biological risks associated with fomites.

Milking Equipment

Milking equipment serves as one of the most significant fomites on a farm. Every adult cow will come in contact with the milking claw and liners two, three, even four times per day. It is essential that this equipment is washed, sanitized and disinfected preferably between every milking, or at a minimum, once every 24 hours. This functions to remove organic debris, disease pathogens, and milk from the claw and pipeline. Any known diseased animals, namely those with mastitis, should be milked last in a string so that the equipment can be cleaned and sanitized afterwards. Since many of the mastitis organisms are directly contagious to other animals, any milk residue that remains in the claw, liners or hoses, runs the risk of exposure to the next animal. There are various methods by which milking equipment can be sanitized between animals. Some facilities have back flush systems directly installed. These function by flushing water through the individual milking claw and hoses to remove the milk residue left behind from each animal. Another method commonly used is a rinse bucket. Used properly, they can remove much of the milk residue and pathogens left in the milking claw. It does not reach the milk hoses however. Specifically, a stainless steel bucket with warm water and a sanitizer or disinfectant mixed at a concentration that will eliminate the target organisms on that facility can be used. Upon completion of milking an infected animal, the claw is removed from the automatic take-off pulley, held upside down and allowed to drain as much milk out as possible. It can then be dipped into the bucket with sanitizer/disinfectant solution and allowed to have appropriate contact time. The unit should be placed in the solution at an angle so as to allow contact with the inside of the liners. This will remove residue and destroy pathogens. If the unit is placed straight in to the solution, it will act like an inverted glass; not allowing sanitizing solution to penetrate. The claw is then lifted out, allowed to drain and then rinsed in a bucket of warm water to remove any residue of sanitizer/disinfectant. Again, it is allowed to drain and can be used on the next cow. Ideally, the sanitizer/disinfectant bucket should only be used once. As organic matter (milk) builds up in the bucket, the sanitizer/disinfectant becomes less effective. This can lead to a false sense of security and actually do more harm than good.

Other fomites commonly found in a milking parlor are teat dip cups. These have the purpose of holding a solution that is used on the teats prior to milking to help disinfect and post milking to help protect the teat end from organism penetration and to moisturize the teat skin. When properly used, they do an excellent job of preparing the teat to be milked in a sanitary manner and protecting from disease entry post milking. Organic buildup in the cups (feces, milk, urine, bedding) deactivates the chemicals and may actually increase exposure to disease causing organisms. Teat dip cups must be monitored for contamination and the solution dumped down the drain, the cup promptly rinsed, washed with detergent and warm water, and then refilled with fresh dip before using on another animal. Never dump the remaining dip back into the original container- too big of a risk of contamination. After each milking, the teat dip cups should all undergo a cleaning/washing procedure. Again, the “solution to pollution is dilution” and by removing organic material and using clean teat dip cups each milking, pathogen load is decreased.

Towels used to wipe teats should be single use to minimize disease exposure and spread. If they are washable, be sure to not overload the washing machine, add detergent and/or bleach to the water before loading to get even dispersal of the solution, use hot water, and ensure adequate time for the cycle to run. Washable towels must be dried completely before the next use. All three elements of hot water, detergent and/or bleach and drying are crucial. A short cut of one step can compromise the entire procedure. Piled up wet towels can harbor and proliferate organisms if not dried completely. Dry towels should be stored in an area to prevent environmental contamination until they are used.

Calf Equipment
Some fomites that need to have special management for calves include esophageal feeders, bottles, buckets, clothing worn by feeders, hutches, others. If calves won't nurse or need oral electrolytes, esophageal feeders can be used. This equipment should be thoroughly washed with warm soapy water, rinsed, then disinfected and hung up to dry with a plastic garbage bag thrown over it to protect it from environmental contamination.

Management recommendations pertaining to milk bottles, buckets, and feeder's clothing can be found on pages 18 and 19.

Calf pens or hutches must be cleaned, sanitized and disinfected between introducing another calf to minimize disease spread. The ground underneath the calf hutch has the potential to harbor pathogens; organic bedding should be removed and the ground allowed to sit idle with sunlight exposure for as long as possible.

Treatment Equipment
All equipment used for treatment - halters, balling guns, esophageal tubes, drenching equipment, needles, syringes, IV lines, oral and vaginal speculums, head catches, and chutes should be cleaned and disinfected. Suspect objects would include anything that could potentially become contaminated with blood, saliva, nasal secretions, urine, feces, or come in direct contact with infected skin or tissues. Some items may need to be disposed of rather than re-used due to the inherent challenges to proper disinfection. Once they are dried, storing these clean items in drawers, plastic bags, or covered up will help to protect them from environmental contamination. Another management strategy to minimize the spread of disease is to work with sick animals only after all healthy animals have been treated.

Other Equipment
Waterers and drinking cups can serve as a fomite if they are not maintained properly. Organic debris can build up over time and harbor disease causing organisms (*Salmonella* sp., *Leptospira* sp.). Waterers should be monitored daily for functionality and cleaned weekly or more often if debris accumulates. See oral transmission for more detail on water quality.

Vehicles, tractors and implements, four wheelers and other machinery often are used in multiple settings within an operation. This presents a very real risk of spreading disease, not only by introducing contamination from one environment to another, but also because cattle are curious animals. It is quite common for cattle to smell, lick and rub against these items, particularly if other animals have done so previously. To reduce the disease risk from these fomites they should be restricted to designated areas, kept clean, and kept from contact with animals to the greatest extent possible. Vehicles frequently in close contact with animals should be restricted to on farm use only or thoroughly cleaned and sanitized when used off of the premises.

Even immovable objects present a potential for spreading disease when naïve animals have contact with them. Examples would include fences, gates, panels, and buildings. It is best to designate areas for each group of animals and limit access of different age groups of animals to a given area.

Contaminated clothing, shoes, or even skin on personnel are additional examples of fomites. For certain zoonotic diseases humans can actually be infected with the organism and shed it into the environment. While this does not fit the strict definition of fomite, it nevertheless requires that people follow proper hygiene and biosecurity standards. This would include at the very least, changing clothes after being in a contaminated environment, and avoiding contact with animals after being in high risk situations (such as travel to countries with foreign animal diseases).

Certain objects have the potential to introduce and spread a disease on the dairy operation. Items of concern would include vehicles and equipment (including portable chutes, tractors and implements, livestock trailers- see traffic below), feedstuffs (possibly refuse or byproducts- see oral, feed), animal husbandry items (needles, syringes, dehorners, halters, etc.), and anything else that has come in contact with infected livestock.

<u>Iatrogenic</u>
Iatrogenic transmission is the unintentional transmission of disease by a medical professional using a contaminated fomite. Since many medical procedures are done on farm by dairy employees, it is imperative that producers recognize that virtually any inanimate object that contacts an infected animal, followed by a susceptible animal can transmit that infection. The "Fomites" section presented previously should be reviewed and considered in relation to iatrogenic transmission of diseases.

Use of products from a multi-dose source can present a risk of iatrogenic spread of disease as well. Producers should be cautious to use aseptic technique in drawing medication from multidose bottles, such as oxytocin in the parlor. The most effective way to eliminate disease spread between animals is to use a new needle and syringe every time an injection has to be given. For example, only a new needle should be injected into a product for a desired dose. Should an additional dose be needed, another clean needle and syringe should be used. This adds expense but decreases disease risk, so the cost/benefit needs to be evaluated for each operation. Caution must be exercised with the type of product used. There is always a chance of human exposure to the product if gloves and eye protection are not used. Some products may have infectious potential if accidentally injected or adsorbed via the mucous membranes of a person.

Many of the products licensed for use on today's dairy farm are single use items (bST, mastitis tubes, dry cow tubes) and are intended to be just that- single use. The manufacturers of these products recognize the disease risk if a needle has blood contact. Due to the sheer nature of why a mastitis tube would be used, contagious organisms are involved and the product must only be used once, and only in one quarter, then properly disposed. The person administering the treatment should wear gloves, wash their gloved hands thoroughly with soap and warm water after treating the infected teat(s) and dispose of their gloves before handling another animal. The alcohol pad used to clean the teat end should also be used only once (on only one teat) and disposed of properly so that another animal does not come into contact with it. Following treatment, the teat should be dipped with a standard post-dip solution to prevent further infection. Proper medication handling is critical as antibiotics can support growth of some organisms, and can result in serious complications when contaminated products are administered parenterally.

The presence of carrier animals in the herd presents an ongoing threat to further spread of disease. A well designed and carefully implemented BRM plan can virtually eliminate all risk of iatrogenic transmission. Some dairy producers are reluctant to commit to the more tedious and expensive components of such a plan, such as a new needle or rectal palpation sleeve for each animal. In these situations, it may be advisable to test for the various diseases of interest and treat or cull carrier animal(s). Alternatively, physically separating them, and working with susceptible animals as a separate group with appropriate disinfection protocols will help limit the spread of certain diseases.

Traffic

Unique and specific risks are presented by vehicle traffic movement on a farm. In the true sense of BRM, the major risk of these activities would be related to their potential as fomites. However, because of the unique challenges associated with controlling traffic and the very real risk that it poses, it should receive additional scrutiny beyond what was previously discussed. The “Fomite” section dealt principally with traffic on the farm, from one group of animals, or area, to another. This section will discuss the risks associated with traffic introducing diseases onto the farm.

Vehicles can transport organisms and deliver them to susceptible animals in a short time. The first step in controlling the threats posed by vehicle traffic is to understand who brings vehicles onto the operation, what vehicles, where they have been, where on the farm they go, why, and how often. This scrutiny should be applied equally to all people, including farm owners and family members, employees, milk truck drivers, veterinarians, renderers, delivery and service vehicles and visitors. The type of vehicle should be noted, from cars and trucks to tractors and other equipment, trailers, portable chutes and any other mobile object that is brought onto the property. An effective means of doing this is to create a visitors log, where everyone is required to sign in and provide the above information. Additionally, all visitors should be requested to contact the operator prior to their arrival and make arrangements to have someone meet them at the appropriate time. This limits the need for people to wander around the farm searching for an office or personnel. It also makes it easier to identify uninvited or unapproved people who may pose a threat to livestock health.

The simplest and most effective vehicle control measure is to have a designated parking area on the perimeter of the farm and request that all visitors be restricted to use of on farm vehicles. This is not always possible, as in the case of milk truck drivers, feed deliveries, veterinarians, and milking equipment service and repair personnel. Standard operating procedures and posted signage should be made available so these people follow proper protocols on the dairy facility to minimize disease spread. If these visitors are required to drive onto the facility, their vehicles should be inspected for cleanliness and ensure their drive path does not have direct animal contact. In the case of feed trucks, deliveries should be made as infrequently as possible. The farm may request to be the first delivery of the day but this may not be practical or acceptable for the feed company. If it is a shared drive path with on-farm vehicles, and the risk exists for introducing a new disease to the farm, a wash down facility and/or a tire washing area with an appropriate disinfectant should be made available and its use strictly enforced. The area should have adequate drainage so as not to contaminate animal areas. In other cases, the “target” may best be brought to the visitor. This could include having a limited access area (again on the perimeter of the property), where equipment can be left for servicing, dead stock can be taken for pick-up (preferably out of sight from main roadways and properties as well as away from all other farm traffic), and pallets of bagged feed or supplies can be left in protected structures.

Animal delivery/load out facilities should be placed in a designated area on the perimeter of the farm. These areas should be well maintained, with gravel, asphalt or concrete surfaces. Adequate drainage away from the farm should be provided to ensure all potential contamination is kept away from animal areas.

Implementation of some of these ideas may be beyond the commitment most producers are willing to make. Potential or perceived obstacles, including facility redesign, new construction, and perceived inconvenience to visitors may discourage many producers. However, for some high traffic- high risk operations, or for producers with extremely valuable genetics, all of these options should be considered. Furthermore, cost and convenience should never serve as an excuse to compromise the BRM plan of an operation. No one should be permitted to drive a soiled vehicle into an animal area. It is not unreasonable to request visitors maintain a sanitary vehicle or park off farm. Similarly, it is not unreasonable to insist that visitors do not drive through areas of concern, such as confinement barns, calf hutch areas, feed areas, water sources, and pastures.

Vector

Diseases can be transmitted by vectors either mechanically or biologically. Mechanical transmission means that the disease agent does not replicate or develop in/on the vector; it is simply transported by the vector from the environment (contaminated feces, feed) or one animal (nasal and ocular secretions) to another. Biological transmission occurs when the vector (mosquitoes, ticks, lice, mites) uptakes the agent, usually through a blood meal from an infected animal, replicates and/or develops it, and then regurgitates the pathogen onto or injects it into a susceptible animal. The prevalence of vector-borne diseases (such as anaplasmosis, bluetongue or vesicular stomatitis virus) is dependent upon the prevalence of the disease agent, distribution of the vector, their abundance, life expectancy, feeding habits and ability to support the pathogens’ existence in their body. The ideal method to prevent vector transmission is eliminating the insect and/or the disease agent from the area. When this is not feasible, other methods such as separating or limiting exposure of the host from the vector and reducing the vector’s breeding areas can be effective.

Eliminating the Insect
Chemical insecticides are frequently used to control insects, but this is invariably ineffective as a sole measure. On a dairy operation, the risk of chemical residues in milk is a huge concern. If the insecticide product is not labeled for use in lactating cattle or on a dairy farm, it should not be used. Residual sprays cannot be used in the milking parlor. If chemical components are used, it is imperative that the manufacturer's instructions be followed. Inappropriate use can present a hazard to the animals and/or environment, can greatly reduce efficacy (using a water based product just prior to rain on animals housed outdoors), and lead to insect resistance (not removing impregnated ear tags from heifers when their efficacy is reduced).

Methods of killing insects include:

- Direct treatment of cattle with pour-ons, ear tags or face rubs
    - To target face flies, one ear tag in each ear is recommended
    - Effective but short-lived duration
    - Insect resistance becoming a problem
- Spraying premises with knockdown insecticides
    - Effective in smaller areas; inefficient in larger areas
    - Must be used the same day they are mixed up
    - Duration short-lived (1-2 hour action)
    - Effectiveness dependent upon weather conditions (target air temperature between 65-90$_o$F for best results)
- Spraying calf hutches/barns with residual sprays
    - Remain active for several days
    - Apply to shaded areas only as ultraviolet light breaks down chemicals
    - Rain will wash away spray so must be reapplied
- Biological control such as parasitic wasps feed on fly larvae, or birds that eat insects
    - Effective but requires repeated introduction of control organism
    - Birds present their own biological disease risks such as spreading salmonellosis, and this should be considered if this option is chosen
    - If used in conjunction with sprays, the parasitic insect may be killed

Separating Host/Vector
Separation of host and vector is needed when a specific region is heavily populated with insects and premise treatment is not practical. This may be necessary to minimize exposure to standing water where mosquitoes lay their eggs, streams where black flies reproduce, and wooded areas heavily infested with ticks. In these cases, the most effective measure may be to fence off these regions during principle insect seasons or confine animals to a building that can be insect-proofed or sprayed with an approved insecticide. In some cases, the presence of carrier animals in the herd presents an ongoing threat to further spread, regardless of how effectively vector control is implemented. In these situations, it may be advisable to test for the various diseases of interest and treat or cull carrier animal(s). Alternatively, physically separating them from susceptible animals has shown some success in limiting spread of certain diseases (BLV, for example). Vaccination of susceptible animals can also be practiced in some cases, but this is generally considered as a last resort.

<u>Breeding Area Control</u>
There are various diseases spread through vectors to cattle (see handout) and each insect has a unique lifecycle that needs to be understood in order to implement specific control measures. This is not an all inclusive list, but rather gives a starting point for control strategies. Most insects can be controlled by:

- Eliminating standing water, especially wet, muddy areas (mosquitoes)
- Eliminating decaying organic matter weekly (flies)

Wet areas may occur around water and feed troughs, in areas where animals congregate, and in old tires used to hold down the plastic covers on silage piles. Measures to control these include frequent cleaning around water and feed troughs, dragging dry lots to spread out fecal pats in cattle congregation areas, cleaning loafing sheds frequently, using tires that have holes punched in them or are cut in half so the treads are removed, and eliminating standing water from various sources.

Decaying organic matter includes spoiled feed, soiled bedding, open manure piles, dead animals, etc. This is especially important in calf hutches. Prompt removal (at least weekly) of these materials limits the ability of insects to breed and feed on them. Dragging dry lots and pastures to disperse fecal pats also reduces the breeding and development of flies. A similar approach involves the use of insect growth regulators in feed, which prevents maturation of insect eggs laid in fecal pats. This practice can be detrimental to other insect species, including some considered favorable. For best effectiveness, the feed supplement must be fed prior to the presence of flies, which can be difficult to predict. Otherwise you have to play catch up with the eggs laid in fecal pats and it is often not economically worthwhile.

Summary

In summary, there are many routes of disease transmission on a dairy farm. Each has specific management protocols that can be established to minimize disease introduction and spread. It is important to assess a farm, identify areas of risk, and use the suggested management strategies to help prevent challenges in the future.

Risk Communication

Risk communication is a two-way, interactive process that has been occurring throughout the risk assessment between the facility owner, risk assessor (veterinarian), the employees and other interested parties. Information has been collected, the analysis has occurred, and now information needs to be delivered to those affected by the risk assessment and risk management plan.

One of the major barriers to effective risk communication is inadequate planning and preparation. Before designing an educational program it is important to consider who is best suited to communicate the message, what message will be most effective, and when and where the information should be communicated.

In large operations, the biological risk management plan may be formulated by upper management, and some employees may not understand the importance of the plan. Risk management plans must be understood, supported, and adopted by every employee for effective implementation. Because many employees may not understand disease transmission routes and the chain of events involved in disease spread, this communication can be difficult and employees may not fully appreciate the significance of the measures they are asked to follow.

Characteristics of effective risk communication:

- It must be adapted to meet the needs of the audience. If bilingual information is required, make sure it is provided;
- It should present the important information in more than one way (appeal to both visual and auditory learners);
- Keep sessions focused to a maximum of three main points and 45 minutes maximum;
- Sessions are more valuable if they are timely and the participants can apply the new information immediately;
- Sessions should cover what, when, where, how, by whom, and why;
- Give participants the opportunity to take ownership of the production process and the ramifications of decisions that impact their area. They should be actively engaged in the question at hand so that they, share information, and most importantly provide input so that decisions become a collective agreement.
- Schedule meetings earlier in the day. Meetings at the end of the working day are less effective.

Educational programs that inform employees and other affected individuals of the risk assessment and management plan can take many forms, and may include:

- Face to face/group meetings (one of the best communication forms if the presenter and participants have open dialogue);
- Newsletter, fliers or bulletin;
- Videos, CD’s, PowerPoint presentations or web-based instruction;
- Posted signs or information panels placed at key locations on the farm (parlor, milk room, calf feeding area, treatment room);
- Employee questions and suggestions (question/answer board, suggestion box, question period during meetings, etc.);
- Mentoring of new employees by experienced employees;
- Recognition or incentive program that rewards employees when BRM goals are reached (this has been used on some farms focused on lowering their somatic cell count, calf death losses, and heat detection rates).

Educational programs should not be limited to one form. Facility owners may incorporate many of the above mentioned education forms to create a program that fits the needs of their facility.

To help the veterinarian facilitate communication, there are handouts about each of the routes of transmission with various applicable diseases provided on the CD-ROM to educate producers about the risk of zoonotic, endemic and foreign animal diseases. The reports that can be printed based on the answers to the assessment question provide a visual tool to the strengths and weaknesses for the various routes of transmission on a dairy farm. The final report graphs that are generated are meant as a visual aid to illustrate potential areas of action. The various risk factors identified have not been quantified or prioritized. It should not be interpreted as an arbitrary number which is required for a facility or veterinarian to "pass," or even that comparable scores for two different facilities mean they face equal risk. The reports should be used to identify if a particular area seems to represent a disproportionate risk and help track progress over time through continued assessments. The management recommendations are made to minimize circumstances that could potentially result in the spread of infectious diseases.

Proper communication of the risk management plan is of utmost importance for effective infectious disease control. When communication is effective and efficient, disease spread can often be minimized and controlled. However, few management plans are successful if records are not kept or some form of biosecurity audit performed so that progress can be measured. Part of the risk communication process should include helping to ensure that a monitoring system is put in place to measure progress.

Conclusion

Biological risk management is an essential component of keeping any dairy operation as clean and secure as possible. Risk of disease transmission cannot be completely eliminated, but by employing some basic hygienic and biological risk management principles, these risks can be effectively managed and significantly reduced. It may take time to persuade your clients to adopt some of these principles, but the results of your efforts will reflect the efficacy of this program, and others will follow suit in time.

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Appendix 2. Management recommendations report

Operation/Client Description: <u>PhD Demonstration Information</u>
Assessment By: <u>Dr. Danelle Bickett-Weddle</u>
Assessment Date: <u>6/16/2007</u>

Management Recommendations

Dairy: General

Question		Response
1	**Are the only animal species on your operation dairy cattle?[DQ1]** *In some cases, the presence of other species on the same operation increases the potential for diseases being spread to cattle. [DM1]	No
2	**Do you know your neighbors?[DQ2]** *Getting to know your neighbors is important as they may be the ones likely to have contact with animals on your farm or assist you in times of need; they should also be aware of your biological risk management plan.[DM2]	No
3	**Do you know what animals your neighbors have?[DQ3]** *It is important to know what types of animals are in your immediate vicinity and knowing what animals your neighbors own and their management style is important when developing and maintaining a successful biological risk management plan for your operation.[DM3]	No
4	**Are your cows kept away from fence to fence contact with other livestock?[DQ4]** *It is important to prevent fence to fence contact with other livestock due to the increased risk of disease spread by direct contact, fomites, aerosol and oral routes.[DM4] *Even in a closed herd situation where new animals are not introduced, disease spread has been documented due to shared fence lines with neighboring animals.[DM5]	No
5	**Are your calves kept away from fence to fence contact with other livestock?[DQ5]** *Even in a closed herd situation where new animals are not introduced, disease spread has been documented due to shared fence lines with neighboring animals.[DM5] *Young stock are more susceptible to disease and it is important to minimize fence to fence contact with other livestock, especially those from neighboring farms that might be carrying diseases this population has no immunity against.[DM6]	No
6	**Do you limit nose to nose contact between animals from different stages and/or age groups?[DQ6]** *It is important to prevent nose to nose contact with other livestock, especially of different age groups, due to the increased risk of disease spread by direct contact and aerosol routes. [DM7]	No
7	**Are fences maintained to minimize animal crossover?[DQ7]** *By maintaining fences (repairing/replacing posts, tightening wires), you minimize the risk of animals escaping, or other animals entering, and mixing with other livestock or wildlife species, which increases their risk of disease exposure.[DM8]	No

Question		Response
8	**Do you try to minimize contact with wildlife?[DQ8]** *Wildlife can transmit many diseases to cattle (e.g. leptosporosis, salmonellosis, brucellosis in some areas) and contact should be minimized. [DM9]	**No**
9	**Do you have deer-proof fences?[DQ9]** *Deer can transmit many diseases to cattle (e.g. leptosporosis, salmonellosis) and contact should be minimized. [DM10]	**No**
10	**Are gates that need to be locked actually locked?[DQ10]** *If gates are installed as a barrier to human entry and intended to be locked to prevent animal contact and subsequent disease exposure (zoonotic or infectious to animals), keeping them locked is essential to maintain a successful biological risk management plan.[DM11]	**No**
11	**Do you have a designated visitor and employee vehicle parking area?[DQ11]** *By having a designated parking area, with posted signs declaring such, visitors and employees have no reason to drive personal vehicles on the farm which can expose animals to diseases or take diseases off the farm to other locations.[DM12]	**No**
12	**Is your vehicle parking area paved/concrete?[DQ12]** *A paved or concrete parking area is easier to clean/wash off should the area become excessively muddy, as compared to gravel. Keeping this area clean is another step in minimizing what organisms are brought onto the farm (via shoes, boots, etc). [DM13]	**No**
13	**Is your vehicle parking area away from main animal traffic areas?[DQ13]** *By having a designated parking area away from animal traffic areas, exposure is minimized with respect to what the vehicles can bring onto the farm or carry off to other areas. [DM14]	**No**
14	**Do you have separate parking areas for employees vs. visitors?[DQ14]** *Separating employee and visitor parking areas can help minimize spread of organisms from unknown sources (visitors) to known sources (employees). There are additional measures that must be taken to minimize employee introduction of disease, but this separate parking areas will help minimize cross-contamination.[DM15]	**No**
15	**Are signs posted and very visible restricting access to your facility to anyone not employed by the operation?[DQ15]** *Posting signs with clear instructions regarding your farm policy for visitors, industry personnel and others will help limit unauthorized access to your animals, feed, and equipment.[DM16]	**No**
16	**Are all vehicles entering your operation inspected for cleanliness?[DQ16]** *Vehicles that enter the farming operation should be clean (tires, wheel wells, undercarriage, body) so as not to contaminate pathways where on farm vehicles or animals will travel; the only way to insure this occurs is to inspect them upon entry.[DM17]	**No**

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Question		Response
17	**Do you have separate vehicles for "on-farm" and "off-farm" use?[DQ17]** *To minimize the risk of introducing disease to the farm, there should be designated vehicles for use on-farm as well as off-farm. If this is not possible, vehicles used off-farm should be cleaned and disinfected appropriately before use.[DM18]	**No**
18	**When using off-farm hauling vehicles, are your loading/unloading areas located at the perimeter of your operation?[DQ18]** *By having loading/unloading areas on the perimeter of the operation, off-farm vehicles will pose less of a risk for introducing disease.[DM19]	**No**
19	**Do you prohibit sharing equipment (including tractors) with other premises?[DQ19]** *When using equipment from other farms, the risk for disease introduction increases. If equipment is shared, it should be inspected for cleanliness and cleaned appropriately (washed down, soap washed, rinsed, disinfected and allowed to dry) before use.[DM20]	**No**
20	**Do you encourage hoof trimmers to sanitize their chutes, tables, knives and other equipment before coming onto the dairy?[DQ20]** *Hoof trimmers typically have access to many dairies, some outside your immediate area. If their equipment is not cleaned and disinfected before coming onto your dairy, the risk of disease introduction is increased.[DM21]	**No**
21	**Do you encourage milk truck drivers to disinfect their tires/wheel wells before coming onto the dairy?[DQ21]** *Milk truck drivers are potentially on several dairies in one day which increases their risk of introducing disease on your dairy if their tires/wheel wells are contaminated and not cleaned before entering your premises.[DM22]	**No**
22	**Is your bulk tank located in such a way that milk truck drivers do not have any contact with animal pathways on farm?[DQ22]** *To minimize the risk of introducing disease to the farm, milk truck drivers should not be allowed to drive in areas where animals will cross the tire path. [DM23]	**No**
23	**If animals are rendered, is the pickup area located on the perimeter and away from all other entrances to your operation?[DQ23]** *Rendering trucks can potentially visit several farms in one day picking up animals that may have died from infectious, contagious diseases. By having the dead pile at the perimeter of the operation and not shared with another drive path, the risk of disease introduction is minimized. [DM24]	**No**

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Question		Response
24	**Do you have a fly control program?[DQ24]** *Flies are known carriers of disease (pink eye, environmental mastitis organisms) and a control program should be implemented to minimize their numbers and thus the risk of disease spread on your farm.[DM27] *A control program should be started 3 weeks prior to the fly season and can include feed additives (which must be used on the entire operation to be effective), insecticide sprays that are cleared for use with lactating animals, fly strips in key locations (parlor, milk house, calving area), and professional monthly or bimonthly spray programs.[DM28]	**No**
25	**If pesticides are used, are the label instructions closely followed?[DQ25]** *A control program should be started 3 weeks prior to the fly season and can include feed additives (which must be used on the entire operation to be effective), insecticide sprays that are cleared for use with lactating animals, fly strips in key locations (parlor, milk house, calving area), and professional monthly or bimonthly spray programs.[DM28] *Pesticides are an important part of insect control but only remain effective when used properly and according to label directions.[DM29]	**No**
26	**Do you have a rodent control program?[DQ26]** *Rodents are known carriers of disease (leptospirosis, hantavirus, salmonellosis) and a control program (bait boxes, solid barriers around feed storage) should be implemented to minimize their numbers and thus the risk of disease spread on your farm.[DM30]	**No**
27	**Are rodent inspections (especially at night) performed often to evaluate infestation levels?[DQ27]** *Since rodents are most active at night, performing inspections at this time can help identify infestation levels. [DM31] *Rodents are carriers of disease and their numbers should be minimized to reduce the risk of disease spread.[DM32]	**No**
28	**Do you have a set schedule and designated person to check all pest control programs to ensure they are kept current?[DQ28]** *In order to remain effective, rodent and pest control programs need to be inspected at least weekly to ensure the bait or insecticide is still present and working; this is best maintained if one person has this responsibility and is accountable for it.[DM33]	**No**
29	**Do you hire a professional pest control person to maintain an effective pest management system?[DQ29]** *Professional pest control programs are very effective against insects and rodents which are carriers of disease. If controlling these areas on farm has proven difficult or unsuccessful, a professional program might be a way to control insects and rodents.[DM34]	**No**

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Question		Response
30	**Is there a three foot weed-free graveled perimeter around all your buildings (for rodent control)?[DQ30]** *Rodents are carriers of disease and their numbers should be minimized to reduce the risk of disease spread.[DM32] *Since rodents often live in brush cover, establishing a weed-free gravel perimeter around animal buildings and feed storage units will make it more difficult for rodents to live in close proximity and spread disease to cattle on your farm. [DM35]	**No**
31	**Is the gravel (rock size) used for building perimeters at least 1 inch in diameter and at least 1/2 foot deep to minimize weed/grass growth?[DQ31]** *To establish an effective rodent-barrier perimeter around buildings (because rodents are disease carriers), gravel rock size and depth are essential to prevent weed growth and burrowing opportunities. [DM36]	**No**
32	**Are steps being taken to minimize bird contact and nesting in your operation?[DQ32]** *Birds are disease carriers and while it is nearly impossible to eliminate them from animal housing areas, steps should be taken to discourage their nesting and roosting.[DM37]	**No**
33	**Are visitors or sales people required to be authorized prior to entering your premise?[DQ33]** *Since visitors and sales people have had unknown animal contact prior to visiting your farm, to minimize the risk of them introducing disease on your farm, require them to make appointments or notify you prior to their visit so that you can inform them of your biological risk management plan.[DM38]	**No**
34	**Do you require visitors to sign in and disclose their last known cattle contact?[DQ34]** *By having visitors disclose their last known cattle contact you can decide what, if any, animal contact they should have on your farm. Collecting this information is also important with regards to disease tracking should an outbreak occur on your farm or in your area.[DM39]	**No**
35	**Do you limit access of visitors who have recently been to foreign countries?[DQ35]** *Many foreign countries have diseases that animals in the United States have no immunity against. [DM40] *By limiting access of people who have recently (last 7-10 days) been to a foreign country, the risk of disease introduction is minimized; often times a devastating disease.[DM41]	**No**

Question		Response
36	**Do you have foreign travel guidelines for your employees and family members?[DQ36]** *Many foreign countries have diseases that animals in the United States have no immunity against. [DM40] *By providing travel guidelines to your employees and family members who visit foreign countries, you are taking steps to prevent disease introduction; often times a devastating disease.[DM42]	**No**
37	**Does everyone who enters your operation (employees, service personnel, visitors) know and understand your BRM protocols?[DQ37]** *In order to have an effective Biological Risk Management plan, anyone who enters your farm should understand the protocols. [DM43] *This can be done through posting signs, employee meetings, sending letters to those people who frequent your facility, and verbalizing your protocols to anyone on your farm.[DM44]	**No**
38	**Do you require everyone to wash their hands with soap and water every time before entering your facility?[DQ38]** *Washing hands is one of the most effective ways to prevent disease transmission, either between people or from people to animals.[DM45] *This is a relatively easy protocol to put in place as a barrier to disease transmission on your facility.[DM46]	**No**
39	**Do you minimize animal contact with anyone entering your operation?[DQ39]** *By minimizing animal contact, there is less risk of disease transmission. [DM47] *Animal contact should be limited to those who know your Biological Risk Management protocols and follow proper hygiene procedures (clean clothes, boots/shoes, and hands) so as to minimize disease exposure.[DM48]	**No**
40	**Do you require clean clothes on everyone entering your operation (visitors, service personnel)?[DQ40]** *Dirty clothes can introduce disease, especially if animal contact occurs. Clean clothes should be required of anyone entering your operation and if not, entry should be denied as the risk of disease introduction increases.[DM49]	**No**
41	**Do you provide clean clothes for everyone entering your operation (coveralls, gloves)?[DQ41]** *By providing clean clothing (coveralls, tyvek suits) to all persons who enter your operation you can help ensure they will not introduce disease organisms; additional hygiene procedures (clean boots/shoes, clean hands) should also be enforced.[DM50]	**No**

Question		Response
42	**Do you require clean footwear on everyone entering your operation (visitors, service personnel)?[DQ42]** *Dirty boots/shoes can introduce disease, especially if they travel where animals can have contact with the same area. Clean boots/shoes should be required of anyone entering your operation and if not, entry should be denied as the risk of disease introduction increases. [DM51]	**No**
43	**Do you provide clean boots (rubber/disposable) for everyone entering your operation?[DQ43]** *By providing clean boots (disposable or rubber) to all persons who enter your operation you can minimize the risk of introducing disease organisms; additional hygiene procedures (clean clothes, clean hands) should also be enforced.[DM52]	**No**
44	**If visitors have their own boots, do you require cleaning and disinfecting them at your facility before entering?[DQ44]** *Having a boot wash area for visitors that have their own boots is essential so that they do not introduce disease. [DM53] *Providing a hose to remove organic matter, a brush for scrubbing, and a disinfectant solution that they can soak their boots in before wearing them onto your farm is important.[DM54]	**No**
45	**Do you provide a boot bath or trash receptacle at the entrance/exit to your operation for ease of cleaning/disposing of footwear?[DQ45]** *Providing a boot bath area or disposable boots and a trash receptacle is a visual reminder for all those entering/exiting your farm that clean footwear is important to your farm's animal disease control plan.[DM55]	**No**
46	**Do you have a water hose to wash off organic matter from boots near the boot bath?[DQ46]** *A boot bath alone is not enough to prevent disease introduction; organic matter must first be washed off with a hose or else the disinfectant is useless.[DM56]	**No**
47	**Do you have a brush to scrub off organic matter from boots near the boot bath?[DQ47]** *Providing a brush for scrubbing off organic matter from boots, along with rinsing with water, prior to using a boot bath with disinfectant helps ensure the organisms are killed and disease is not introduced or spread on farm.[DM57]	**No**
48	**Are boot baths maintained properly (changed when organic matter contaminates it or at least daily)?[DQ48]** *In order for boot baths to remain effective, they should be kept clean with minimal amounts of organic matter, as this makes the chemical ineffective; changing the solution daily and cleaning the container in between filling is ideal.[DM58]	**No**
49	**Do you require everyone to wash their hands with soap and water every time before leaving your facility?[DQ49]** *Washing hands is one of the most effective ways to prevent disease transmission, either between people or from people to animals.[DM45]	**No**

Question		Response
50	**Are coveralls (or any other special attire) required to be worn by employees while working with cattle?[DQ52]** *By requiring all employees to wear clean clothing (coveralls, tyvek suits) when working with cattle on your operation you can help ensure they will not introduce disease organisms; additional hygiene procedures (clean boots/shoes, clean hands) should also be required. [DM61]	**No**
51	**Are employees trained to know when their clothing is considered "dirty" enough to require changing?[DQ53]** *Protocols should be established for when clothing becomes too dirty or contaminated to wear around cattle and employees should be instructed to follow these protocols.[DM62]	**No**
52	**Is your work/farm clothing restricted from being worn outside of your operation?[DQ54]** *Protective clothing worn on farm should remain on farm so as not to contaminate vehicles or other locations; it also helps prevent organisms being introduced if protective clothing does not leave the premises.[DM63]	**No**
53	**Do you request that your employees avoid contact with livestock outside of your operation?[DQ55]** *Since cattle can carry diseases without showing symptoms, employees should limit their contact with other livestock outside of your operation as diseases can be introduced if proper hygiene (clean clothes, boots/shoes, hands) protocols are not followed.[DM64]	**No**
54	**Do you require employees to report ownership of offsite owned livestock?[DQ56]** *Animal contact outside of the operation can increase the risk of disease introduction so talk with your employees to identify who owns animals, what types, and establish protocols such as different clothing and footwear for your operation, hand washing, and notification of any sick animals on your employee's farm to minimize disease spread.[DM65]	**No**
55	**Are employees required to change clothing when moving into special areas of the farm such as the maternity and calf areas?[DQ57]** *Some animals within an operation can be more susceptible to disease than others (young stock, pregnant animals) and contaminated clothing can spread disease to this population; clean clothing can minimize disease spread to these susceptible animals.[DM66]	**No**
56	**Are laundering facilities available on farm for washing work clothes?[DQ58]** *Providing laundry facilities on farm for work clothes ensures they remain on farm and minimizes the risk of employees bringing home disease agents to their family or animals. [DM67]	**No**

Question		Response
57	**Are laundering facilities restricted for use of work clothes only?[DQ59]** *Many times on a dairy, cloth towels need to be washed and dried between uses in the parlor; separate facilities for work clothes can help minimize the cross contamination of items in the laundry area. If it is not possible to have separate facilities, an empty wash load with bleach should be done between work clothes and cloth towels and storage facilities for clean items should be made available so contamination does not occur.[DM68]	**No**
58	**Are employees required to wear latex/nitrile gloves when working with animals?[DQ60]** *Wearing latex/nitrile gloves can help protect the worker from disease exposure if their hands have cuts or abrasions on them; however, they are not a substitution for good hand hygiene when working with animals.[DM69]	**No**
59	**Have protocols been established to determine how often latex/nitrile gloves need to be changed?[DQ61]** *As gloves can become contaminated, protocols should be established and employees should know when gloves need to be changed to minimize the risk of disease spread.[DM70]	**No**
60	**Are employees required to change their latex/nitrile gloves when moving to a different area of the operation?[DQ62]** *Some animals within an operation can be more susceptible to disease than others (young stock, pregnant animals) and contaminated gloves can spread disease to this population; clean gloves can minimize disease spread to these susceptible animals and this protocol should be in place for various areas on the farm.[DM71]	**No**
61	**Are work boots restricted from being worn in the public traffic/office areas?[DQ63]** *Dirty boots/shoes can introduce/spread disease, especially if they are worn in common traffic areas where the public could pick up the contamination and spread it to other locations. Low risk visitors can become high risk to the next farm if they are exposed to disease pathogens in this manner.[DM72]	**No**
62	**Are employees required to clean and disinfect their boots when moving into special areas of the farm such as the maternity and calf areas?[DQ64]** *Some animals within an operation can be more susceptible to disease than others (young stock, pregnant animals) and contaminated boots can spread disease to this population; clean footwear should be required when working with these susceptible animals.[DM73]	**No**
63	**Do employees have easy access to hand washing stations or hand sanitizers?[DQ65]** *Washing hands is one of the most effective ways to prevent disease transmission, either between people or from people to animals.[DM45] *Providing hand washing stations or alcohol gel hand sanitizers in areas where contamination (parlor, calf area, barns) is common can help protect your employees from disease exposure as well as the animals on your farm.[DM74]	**No**

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Question		Response
64	**Are there requirements for how often or when hands need to be washed?[DQ66]** *Stressing the importance of frequent hand washing and identifying when it should occur on your farm will help ensure your employees minimize exposure to themselves and spread to other animals.[DM75]	**No**
65	**Does someone regularly (weekly) monitor soap and towels in handwashing areas?[DQ67]** *In order for personnel to properly wash and dry their hands, soap and towels need to be monitored at least weekly to ensure they are available; this is best maintained if one person has this responsibility and is accountable for it.[DM76]	**No**
66	**Do you have signs posted in restrooms and the milkroom promoting hand washing?[DQ68]** *Signs serve as good reminders to employees and visitors about the importance of hand washing and should be posted in key areas (restrooms, eating areas, milkroom, calf areas). [DM77]	**No**
67	**Do employees have access to toilet facilities at all times?[DQ69]** *Humans can be disease carriers for animals and should have well-maintained (clean, toilet paper, wash station with towels) toilet facilities available to them to minimize disease exposure. [DM78]	**No**
68	**Do you have restrictions on where food and drinks are allowed on your premise?[DQ70]** *There are diseases that animals carry that humans are susceptible to (zoonotic diseases) and food and drinks should be restricted to non-animal contact areas so that the risk of disease exposure (Salmonella for instance) is minimized. [DM79]	**No**
69	**Do you have a separate refrigerator for human food and drinks?[DQ71]** *Food and drinks for human consumption should be stored in a refrigerator separately from vaccines, antibiotics, and milk samples so as to decrease the risk of cross contamination. [DM80]	**No**
70	**Are all animals individually identified?[DQ72]** *If more than one person works on an operation, individual animal identification is imperative for proper communication of health status, treatment needs, antibiotic withdrawal/residue prevention status, and location on farm.[DM81] *Individual animal identification is imperative for proper record keeping (vaccinations, treatments, pregnancy status) which is an integral part of managing animals and minimizing disease risk on farm.[DM82]	**No**
71	**Do you keep treatment records for all animals?[DQ73]** *Keeping treatment records on a dairy is an integral part of minimizing disease risk on farm because protocols can be tracked over time with your veterinarian and used to determine whether things are working in various disease situations.[DM83]	**No**

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Question		Response
72	**Do you keep treatment records for lactating animals?[DQ74]** *Keeping treatment records on a dairy is an integral part of minimizing disease risk on farm because protocols can be tracked over time with your veterinarian and used to determine whether things are working in various disease situations.[DM83]	**No**
73	**Do you keep treatment records for all replacements?[DQ75]**	**No**
74	**Do you keep treatment records for dry cows/pre-fresh animals?[DQ76]**	**No**
75	**Are all animals inspected daily for signs of illness?[DQ77]** *Animals treated early in an infection respond more favorably so animals should be inspected daily for signs of illness and promptly removed from their group, examined fully, and treated according to protocols established with your veterinarian to minimize disease spread on farm. [DM84]	**No**
76	**Do you have an established program for everyone to be able to recognize and report diseases?[DQ78]** *By establishing and educating all employees on what to look for regarding sick animals and having a reporting system so that those in charge can make treatment decisions or the veterinarian can be contacted, serious diseases can be identified early on and therefore minimize the risk of disease spread on farm.[DM85]	**No**
77	**During chores, do you move from "clean" younger animals to "older" animals, to "dirty"/sick animals, and finally isolation animals?[DQ79]** *Some animals within an operation can be more susceptible to disease than others (young stock, pregnant animals) and chores should be conducted in such a way that the most susceptible, healthy animals are worked with first (calves, young stock) and then the older, healthy animals, leaving the sick animals and those in isolation for last to minimize disease spread on farm.[DM86] *Proper hygiene procedures (clean clothes, boots/shoes, and hands) should be adhered to when moving between different animal areas on farm so as to minimize disease exposure. [DM87]	**No**
78	**Are animals that are not going to recover euthanized humanely and promptly?[DQ80]** *Animals that are not going to recover can serve as a reservoir for many disease organisms and should be euthanized humanely and in a timely manner in order to minimize disease spread on farm.[DM88]	**No**
79	**Are dead animals removed from the operation immediately after euthanasia?[DQ81]** *Dead animals can serve as a reservoir for many disease organisms and should be promptly removed from the operation so that disease spread is minimized.[DM89]	**No**

Question		Response
80	**Are dead animals properly disposed of (rendered, composted)?[DQ82]** *Dead animals need to be rendered, composted or buried immediately after euthanasia so as not to spread disease on farm through predators, wild birds, etc.[DM90]	**No**
81	**If animals are rendered, is the dead pile protected from predators?[DQ83]** *As dead animals can be carriers of disease, it is imperative that they are protected from predators that may eat them or spread infectious carcass parts throughout your operation. [DM25] *This can be done by building a 4 sided shelter with one side that opens wide enough for a tractor to drive in and deposit/remove a carcass. It should also be covered so birds cannot enter and sidewalls designed so animals cannot easily burrow underneath and get to the carcass.[DM26]	**No**
82	**Do you have a veterinarian necropsy all animals that die from undetermined causes?[DQ84]** *By having a veterinarian necropsy animals that die of undetermined causes, a diagnosis may be obtained by sending samples into a diagnostic laboratory.[DM91] *Unusual diseases may not present in a manner you are used to, so involving a veterinarian may help identify a potentially infectious disease before it becomes widespread on your facility. [DM92]	**No**
83	**After they are cleaned, is the medical equipment (balling guns, esophageal tubes, syringes) stored in a dry, dust free place?[DQ85]** *Storing clean medical equipment in a dry, dust free place will help prevent cross contamination between uses and without moisture, residual organisms cannot grow and spread disease the next time it is used.[DM93]	**No**
84	**Are non-refrigerated vaccines and antibiotics kept out of sunlight?[DQ86]** *Sunlight deactivates vaccines and can render antibiotics ineffective, causing inadequate protection or treatment when used in your animals; make sure you read the label and store properly. [DM94]	**No**
85	**Do you regularly monitor your medicine/vaccine refrigerator for proper cooling temperatures (36-46˚F)?[DQ87]** *Vaccines and medicines that need to be refrigerated are susceptible to changes in temperature and may not be effective if they get too warm (greater than 46 degrees Fahrenheit) or too cold/frozen (less than 36 degrees Fahrenheit); monitoring your refrigerator at least monthly can help ensure the biologicals are adequately stored.[DM95]	**No**

Question		Response
86	**Do you restrict who has access to medications and vaccines used on the dairy?[DQ88]** *Work with your veterinarian to teach proper handling procedures to all people who routinely deal with vaccines and medicine. [DM226] *All individuals that handle or administer medicine or vaccines should be properly trained so the products have maximal efficacy and do not cause any harm to the person (needle sticks, splashing into the eyes or mouth).[DM227]	**No**
87	**Do you prohibit the reuse of disposable supplies (mastitis tubes, needles)?[DQ89]** *Disposable supplies are designed to be one-time use products and are often not designed to be cleaned and re-used.[DM96] *Re-using disposable supplies can increase the risk of disease spread and often the cost does not justify the cleaning and disinfecting which should be done if it is going to be used on more than one animal.[DM97]	**No**
88	**Do you change OB/AI sleeves after each cow?[DQ90]** *Changing OB or AI sleeves between each cow minimizes the risk of disease spread (BLV, Johne's) between animals; however, this decision must be applied to all personnel (farm employees, veterinarians, AI technicians) to be effective.[DM98] *Work with your veterinarian to establish what diseases on your farm could be reduced by implementing this step. [DM99]	**No**
89	**Do you have an established internal parasite control program for each production stage?[DQ91]** *Internal parasites can affect growth rates and immune status, making animals more susceptible to diseases; control them throughout the year by sticking to an established control program designed with the help of your herd veterinarian.[DM100]	**No**
90	**Do you have an established external parasite control program for each production stage?[DQ92]** *External parasites can affect the growth rate, production, and health status of cattle making them more susceptible or even causing disease themselves; control them through an established treatment regimen (appropriate pour-on, back rubbers, ear tags).[DM101]	**No**

Question		Response
91	**Is there a mound or other dry place where animals can lay down when outside?[DQ93]** *It is important to provide a dry place for animals to lay down when outside so that their udders do not become covered with mud/feces as this can lead to infections/mastitis. [DM102] *Mounds should be included in pens where there is a tendency for water buildup after a rain to give animals a high and dry place to lay. [DM103] *The slope of the entire pen should be 2-4% to allow for drainage with occasional low, flatter mounds (4-6 feet high, 1 to 5 inch slopes, 35 sqft per head) for animals to lay on and keep dry.[DM104]	**No**
92	**During the dry season, are you able to control dust in dry lots?[DQ94]** *Dust is an irritant to the throat, lungs and eyes and can predispose cattle to conjunctivitis and respiratory disease if their mucus membranes get damaged. [DM105] *There are products available to minimize dust in dry lots, as well as water mists that can be applied; however, excessive amounts of water can lead to mud which is not ideal for cattle either.[DM106]	**No**
93	**Is the dry lot area regularly maintained to prevent manure buildup and areas of stagnant water?[DQ95]** *Manure can carry disease organisms and should not be allowed to build up in pens so that cattle are constantly laying in it; dragging the lots (weekly, more often if wet or dense with animals) to spread out the fecal pats and allowing them to dry will help minimize the pathogen load and decrease exposure.[DM107] *Stagnant water can carry disease causing pathogens and is a breeding ground for mosquitoes; proper drainage should be instilled or fence off the area so that cattle cannot walk through or drink from it to minimize disease exposure.[DM108]	**No**
94	**Do you keep your alley ways clean (scraped or flushed at least one time daily)?[DQ96]** *Manure can carry disease organisms and should not be allowed to build up in areas where cattle travel as it can splash up on the udder or into the feedbunk; alley ways should be scrapped or flushed at least once daily to minimize disease exposure.[DM109]	**No**
95	**Do you keep your stalls clean (scraped at least one time daily)?[DQ97]** *Cows need a clean place to lay down so stalls should be monitored at least daily, preferably at every milking, for manure contamination and manure promptly removed to decrease disease exposure to the udder and reproductive tract.[DM110]	**No**
96	**Do you keep your stalls dry (refilled with bedding)?[DQ98]** *Cows need a dry place to lay down so stalls should be monitored daily to ensure enough bedding is available and refilled to encourage stall usage and promote cleanliness of the udder. [DM111]	**No**

Question		Response
97	**Are you able to regulate your indoor ventilation based on seasons (fans, curtain side walls, sprinklers)?[DQ99]** *Adequate ventilation is essential to respiratory health and barns should be equipped to handle heat and humidity extremes (fans, curtain side walls, sprinklers) and prevent the buildup of stagnant air (ammonia, methane).[DM112] *Ventilation requirements vary based on building style but for every foot of fan diameter placed at a 30 degree angle, it will blow 10 feet. [DM113]	**No**
98	**Is your indoor humidity equal to or less than the outdoor humidity in warm weather months?[DQ100]** *High humidity levels in a barn can decrease ventilation and air, carrying disease pathogens, can become stagnant making animals more susceptible to respiratory disease.[DM114]	**No**
99	**Do you have a humidistat in each barn?[DQ101]** *Monitoring humidity in the barn is part of a good ventilation plan, allowing you to make fan and side curtain adjustments so that air does not become stagnant and pathogens build up that can cause respiratory disease.[DM115]	**No**
100	**Do you separate sick cows (potentially contagious) from healthy cows ASAP?[DQ102]** *Cows that are identified as ill should be removed from the rest of the herd immediately and placed in an isolation area where ventilation and direct contact is not shared with other animals in order to minimize the risk of disease spread.[DM116]	**No**
101	**Do you have an isolation area for sick animals on farm?[DQ103]** *Having an isolation area that is strictly for use by sick animals can help decrease the spread of disease on farm if the ventilation, feed/water and equipment is not shared with the rest of the animals on farm.[DM117]	**No**
102	**Do you have an area used only for quarantine for newly introduced animals?[DQ104]** *Newly introduced animals may be carrying diseases that your home herd is not immune to, so isolating them for a period of time (determined together with your herd veterinarian) in an area that does not share ventilation, feed/water, and other equipment with the rest of the herd is essential to minimize disease introduction to your operation.[DM118]	**No**
103	**Do you have written/posted protocols regarding when sick/treated animals can be returned to the herd?[DQ108]** *By having written/posted protocols for when animals are allowed to be removed from isolation, everyone on the operation knows the plan and animals must meet them (normal temperature, no discharge, culture negative for mastitis/uterine infection, etc) so as not to expose herd mates to disease.[DM123]	**No**
104	**Do you have written standard operating procedures (SOPs) for milking?[DQ117]** *Milking should be a routine, and if more than one person has this responsibility on farm, writing down the standard operating procedure (SOP) lets everyone know specifically how it is to be done, ultimately minimizing the risk of disease (mastitis).[DM132]	**No**

Question		Response
105	**Does the same person train all the personnel on the milking procedure?[DQ118]** *Milking should be a routine and it is ideal if the same person trains all individuals how it is to be done, specifically how to monitor for mastitis and the proper procedure to follow to help prevent it from occurring and spreading disease.[DM133]	No
106	**Do milkers wear gloves?[DQ119]** *Wearing latex/nitrile gloves can help protect the worker from disease exposure if their hands have cuts or abrasions on them; however, they are not a substitution for good hand hygiene when working with animals.[DM69]	No
107	**Are cows' udders/teats clean before attaching the milking units?[DQ120]** *Cows should have clean udders/teats before attaching the milking unit otherwise the organisms present can enter the milk and predispose cows to mastitis through injection of organisms into the teat end.[DM134] *If the majority of cows enter the parlor with dirty udders/teats (cleanliness score greater than 2), stalls or loafing areas should be investigated for dirty, contaminated areas and promptly cleaned or scraped to minimize the risk of disease exposure. [DM135]	No
108	**Do you use pre-milking teat dips?[DQ122]** *Pre-milking teat dips, when applied to all teats with full coverage and allowed to have contact time for 15-30 seconds, serve to reduce the bacterial numbers on the teat and, in some cases, reduce the risk of new mastitis cases by 50%.[DM137]	No
109	**Is the pre-dip solution allowed to have at least 15-20 seconds of contact time?[DQ123]** *In order for pre-dips to work effectively at reducing bacterial numbers on teats, they must be applied to have full coverage on all teats and allowed to have contact for at least 15-20 seconds; up to 30 seconds when environmental mastitis challenges exist.[DM138]	No
110	**Are cows' teats wiped completely dry before attaching the milking unit?[DQ124]** *Milking units should be attached to dry teats to prevent slippage, which allows milk to inject back into the teat, potentially causing mastitis if disease organisms exist.[DM139]	No
111	**Do you use single service (washable/disposable) towels?[DQ125]** *To minimize disease exposure between cows at milking, single service towels should be used and discarded into the trash, wash bin, or pouch before handling the next clean towel. [DM140]	No
112	**Is the milking unit attached within 60-120 seconds after first touching the cow's teat?[DQ126]** *For maximal milk let down and to minimize teat end damage that can lead to mastitis development, the milking unit should be placed on the cow's teat within 60-120 seconds after the first stimulation step (dipping, forestripping, or wiping).[DM141]	No

Question		Response
113	**Is the milking unit monitored for liner slips throughout milking?[DQ127]** *Liner slips can cause milk to be injected back into the teat, potentially causing mastitis if disease organisms exist, so minimizing liner slips is important to lowering this risk.[DM142]	**No**
114	**Is the milking vacuum always shut off prior to removing the milking unit?[DQ128]** *If not shut off prior, vacuum pressure can damage the teat end upon milking unit removal which can increase the risk of disease organisms entering the teat because the natural barrier is damaged.[DM143]	**No**
115	**Do you use post-milking teat dips?[DQ129]** *Post-milking teat dips should be applied to the lower third of all teats to minimize the risk of contagious organisms entering the teat canal and causing mastitis.[DM144] *In cold weather (less than 10°F or with wind chill), post-milking teat dips should be applied, allowed to have contact for 30 seconds and the excess removed with a single use towel to prevent frost bite, subsequent teat end damage, and decrease mastitis risk.[DM145]	**No**
116	**Are workers trained to dispose of used dip solutions and not pour it back into the main container?[DQ130]** *Used dip solutions in teat dip cups should be discarded rather than putting it back into the container to minimize organic matter and pathogen contamination of the bulk supply; organic matter causes teat dips to lose effectiveness.[DM146]	**No**
117	**Are dip cups emptied, washed, and allowed to dry out before refilling?[DQ131]** *Teat dip cups become contaminated with manure and bedding during milking and should be emptied, rinsed, washed with detergent, and allowed to dry before refilling to increase the effectiveness of the new teat dip and decrease the risk of disease transmission.[DM147]	**No**
118	**Are cows kept on their feet for at least 30-45 minutes after milking to allow keratin plug formation in the teat canal?[DQ132]** *Teat ends remain open for 30-45 minutes after milking before the keratin plug forms; cows should be kept on their feet (offer fresh feed, keep water troughs available) during this time to minimize the risk of disease organisms entering the teat canal and causing an infection. [DM148]	**No**
119	**Do you have regular maintenance schedules for your milking equipment?[DQ133]** *Milking equipment needs to be frequently monitored to make sure the vacuum pressure is not too high which can cause teat end damage and subsequent infections. Liners should be changed according to manufacturers recommendations to prevent cracking and bacteria build up, and other systems checked as necessary to minimize any disease risk to the cows. [DM149]	**No**

Question		Response
120	**Is your somatic cell count routinely under 200,000?[DQ134]** *Somatic cell count is an indicator of udder health and counts over 200,000 leave opportunity for improvement; work with your herd veterinarian to establish problem areas or cows and a plan to improve udder health.[DM150]	**No**
121	**Do you do routinely monitor bulk tank somatic cell counts?[DQ135]** *Milk companies make somatic cell counts available, sometimes daily, so it should be routinely monitored on farm as it is an indicator of udder health and can provide a measuring tool for proper milking procedures and cow cleanliness.[DM151]	**No**
122	**Do you use a CMT paddle on individual cows to monitor for mastitis?[DQ136]** *California Mastitis Test (CMT) paddles can be used on individual cows to monitor for mastitis and when used regularly as part of a monitoring program, are effective at identifying infections early in their course of disease.[DM152] *Failure to notice mastitis in a cow, which a CMT allows, can spread disease organisms to the next cow if the milking unit is not rinsed and sanitized between animals.[DM223]	**No**
123	**Do workers wash their hands with soap and water after milking/treating mastitic cows?[DQ137]** *Cows with mastitis shed thousands, even millions of organisms in their milk and to prevent exposure to other cows, milkers should wash their hands after milking, treating, or handling the udder of infected cows.[DM153]	**No**
124	**Do you culture milk from individual cows with mastitis for contagious organisms?[DQ138]** *Contagious mastitis organisms require special handling (milking last, special treatments, culling) and infected cows should have their milk cultured to identify the organism and decide what steps should be taken to minimize exposure of other cows or humans drinking unpasteurized milk.[DM154]	**No**
125	**Do you routinely monitor bulk tank cultures for contagious organisms?[DQ139]** *If there is a mastitis or high somatic cell count problem on farm, bulk tank cultures can be obtained to help identify the causative agent but not the individual(s) infected; work with your herd veterinarian to determine if this diagnostic procedure is appropriate for your farm and how to handle the results once they are obtained.[DM155]	**No**
126	**Are chronic mastitis animals removed from your operation ASAP?[DQ140]** *Chronic mastitis cows shed thousands, even millions of organisms in their milk and to prevent exposure to other cows or humans if zoonotic, these animals should be culled.[DM156]	**No**
127	**Is milking equipment washed, sanitized and disinfected between EVERY milking?[DQ141]** *Milk is an excellent medium for bacterial growth (warm, moist, sugars for energy) and to prevent this from occurring in the milking unit and pipelines, the system should be washed, sanitized, and disinfected between every milking.[DM157]	**No**

Question		Response
128	**Is milking equipment washed, sanitized and disinfected at least once every 24 hours?[DQ142]** *Milk is an excellent medium for bacterial growth (warm, moist, sugars for energy) and to minimize this from occurring in the milking unit and pipelines, the system should be washed, sanitized, and disinfected at least once every 24 hours.[DM158]	No
129	**Is food for human consumption prohibited in the parlor?[DQ143]** *There are diseases that animals carry that humans are susceptible to (zoonotic diseases) and food and drinks should be restricted to non-animal contact areas so that the risk of disease exposure (Salmonella for instance) is minimized. [DM79]	No
130	**Do you have an established internal parasite control program for lactating cattle?[DQ144]** *Internal parasites can affect growth rates and immune status, making animals more susceptible to diseases; control them throughout the year by sticking to an established control program designed with the help of your herd veterinarian.[DM100]	No
131	**Do you have an established external parasite control program for lactating cattle?[DQ145]** *External parasites can affect the growth rate, production, and health status of cattle making them more susceptible or even causing disease themselves; control them through an established treatment regimen (appropriate pour-on, back rubbers, ear tags).[DM101]	No
132	**Do you remove calves from mothers at birth, not allowing them to nurse?[DQ155]** *By removing calves immediately after birth, prior to nursing, the colostrum can be harvested in a more sanitary manner, tested for quality with a colostrometer, and the amount monitored to ensure the newborn receives 4 quarts within the first 6 hours.[DM167]	No
133	**If you do not immediately remove newborn calves at birth, do you prevent calves from nursing cows?[DQ156]** *Newborn calves are highly susceptible to disease and colostrum quality and intake should be monitored at the first critical feeding, so to keep calves from nursing the cow, deeply bed the stall (2-3 feet of straw/fodder) so that it cannot easily stand and suckle, or put an udder support/bra on the cow so if it does stand to nurse, it is prevented; the cows legs and tail should be clean so that the calf does not nurse on them and absorb a mouthful of bacteria laden-manure.[DM217]	No
134	**Is maternity equipment cleaned and disinfected immediately after use?[DQ158]** *Obstetrical chains, handles, and calf jacks should all be cleaned immediately after use, disinfected, and allowed to dry so as to decrease the risk of disease spread between uses. [DM169]	No
135	**Is maternity equipment protected from contamination between uses?[DQ159]** *Once maternity equipment (obstetrical chains, handles, calf jack) is cleaned and disinfected, it should be stored in a protected area (cabinet, drawer) or covered with a plastic bag so contamination does not occur between uses.[DM170]	No

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Question		Response
136	**Do you clean the cow's udder before collecting colostrum?[DQ160]** *If the cow's udder is soiled, it must be cleaned before harvesting colostrum so as to minimize contamination of the product; newborns are extremely susceptible to disease and pathogens can be absorbed as easily as proteins (antibodies) in colostrum and this risk must be minimized.[DM171]	No
137	**Do you collect colostrum within the first 2 hours after calving?[DQ161]** *Once a calf is born, colostrum begins to be diluted with milk, which requires more to be fed to the calf to get the maximal amount of proteins (antibodies) absorbed to ensure a working immune system in the newborn.[DM172]	No
138	**Do you use a colostrometer to determine poor versus good quality colostrum?[DQ162]** *A colostrometer can be used to identify poor versus good quality colostrum and serve as a guide for how much should be given to the calf to maximize immune protection.[DM173]	No
139	**Do you immediately refrigerate colostrum that is not going to be fed for 2-4 hours in a sealed, single use container?[DQ163]** *Colostrum is an excellent medium for bacterial growth (warm, moist, sugars for energy) and to minimize this, unfed colostrum should be packaged in clean, single use containers (sealed plastic baggies, palpation sleeves, half-gallon plastic bottles), labeled with cow ID and date, and refrigerated immediately.[DM174]	No
140	**Do you immediately freeze your colostrum if it will be stored for more than 24 hours in a labeled, sealed, single use container?[DQ164]** *Colostrum is an excellent medium for bacterial growth (warm, moist, sugars for energy) and to minimize this, unfed colostrum should be packaged in clean, single use containers (sealed plastic baggies, palpation sleeves, half-gallon plastic bottles), labeled with cow ID and date, and frozen if it is not going to be fed for 24 hours or more.[DM175]	No
141	**Do you always use the best quality colostrum for first time feedings?[DQ165]** *A calf's immune system depends on the amount of antibodies (protein) in colostrum and the best quality (as tested by a colostrometer) should be fed at first feedings, especially in calves born to first time calving heifers.[DM176]	No
142	**Do you only use single source colostrum, not pooled from multiple cows?[DQ166]** *Organisms can be shed into colostrum and to minimize exposure, especially if the product or cow have not been tested, it should never be mixed with other sources as the risk of disease spread increases with multiple sources fed to a calf.[DM177]	No
143	**Do you only use colostrum from test negative cows (BLV and Johne's)?[DQ167]** *Diseases, such as Johne's and Bovine Leukosis Virus (BLV), can be shed in colostrum and to prevent spread to calves, the suspect cow should be tested prior to calving so that test results are available and a decision can be made to throw away or feed the colostrum.[DM178]	No

Question		Response
144	**Do you give newborns 3/4 to 1 gallon of colostrum within the first six hours of life?[DQ168]** *A calf's immune system depends on the amount of antibodies (protein) in colostrum and 3/4 to 1 gallon of the best quality should be fed within the first 6 hours of life.[DM179]	**No**
145	**Do you give a second dose (1/2 to 3/4 gallon) of colostrum 12 hours later?[DQ169]** *To maximize the amount of antibodies (protein) absorbed by a newborn calf, a second feeding of 1/2 to 3/4 of a gallon should be fed 12 hours after the first feeding (3/4 to 1 gallon). [DM180]	**No**
146	**Do you store your milk replacer in a tightly sealed container to prevent contamination?[DQ170]** *Milk replacer is a good medium for bacterial growth, especially if it is not stored in a sealed container that prevents moisture and contamination from occurring.[DM181]	**No**
147	**Do you pasteurize waste milk before feeding to calves?[DQ171]** *Waste milk is often loaded with disease causing organisms and fed to the most susceptible animals on the farm (calves); pasteurization (proper time and temperature- monitored each batch) will destroy the pathogens and minimize the risk of disease spread if done correctly. [DM182]	**No**
148	**Do you clean all buckets, bottles, and nipples after each feeding?[DQ172]** *Milk is an excellent medium for bacterial growth (warm, moist, sugars for energy) and to prevent this from occurring, the calf feeding equipment should be washed, sanitized, and allowed to dry between every feeding.[DM183]	**No**
149	**Do you clean and sanitize all milk replacer mixing and handling equipment after each feeding?[DQ173]** *Milk is an excellent medium for bacterial growth (warm, moist, sugars for energy) and to prevent this from occurring, the milk mixing/handling equipment should be washed, sanitized, and allowed to dry between uses.[DM184]	**No**
150	**Are coccidiostats a regular part of your calf feeding program?[DQ174]** *Coccidiostats fed to calves in starter feed help reduce the prevalence of coccidia in the intestinal tract, decreasing the risk of disease from this parasite and other secondary infections (like E. coli, rotavirus, coronavirus).[DM185]	**No**
151	**Do you utilize individual calf housing for newborn calves and ensure there is no direct contact between them?[DQ175]** *Individual calf hutches, when placed on clean ground, shaded from heat, and bedded well in the winter time, help protect the calf from environmental exposure to disease pathogens, prevent calf to calf contact if correctly placed, and decrease the amount of respiratory pathogens if located in an area with good air flow.[DM186]	**No**

Question		Response
152	**Do you thoroughly clean, disinfect and allow all calf hutches to completely dry between uses?[DQ177]** *Calf hutches can harbor disease organisms and should be removed from their location, the inside and outside washed down, organic matter scrubbed off, rinsed with a sanitizer or disinfectant, and turned upside down and allowed to dry before reusing (as should the ground where the calves were house be allowed to dry after bedding is removed).[DM188]	**No**
153	**Do you investigate all abortions or at least those above a set threshold?[DQ180]** *Abortions can be caused by a variety of things so if more occur than expected (as determined together with your herd veterinarian), it may be worthwhile to submit samples to a diagnostic laboratory to identify the cause and best course of treatment.[DM192] *Work with your veterinarian to establish what diseases on your farm could be reduced by implementing this step. [DM99]	**No**
154	**Do you have an established internal parasite control program for dry cows/pre-fresh animals?[DQ181]** *Internal parasites can affect growth rates and immune status, making animals more susceptible to diseases; control them throughout the year by sticking to an established control program designed with the help of your herd veterinarian.[DM100]	**No**
155	**Do you have an established external parasite control program for dry cows/pre-fresh animals?[DQ182]** *External parasites can affect the growth rate, production, and health status of cattle making them more susceptible or even causing disease themselves; control them through an established treatment regimen (appropriate pour-on, back rubbers, ear tags).[DM101]	**No**
156	**Do animals have access to clean, fresh water all day?[DQ183]** *Animals that become dehydrated are more susceptible to disease so make sure each animal on farm has access to fresh, clean water all day everyday, especially calves.[DM193] *In order for animals to meet their water intake needs, they will seek out available sources, contaminated or not, so to minimize exposure to pathogens, provide clean, fresh water to them at all times.[DM225]	**No**
157	**Do you clean water troughs/cups frequently (at least weekly)?[DQ184]** *Water troughs/cups are excellent areas for bacterial or fungal growth to occur (moist, organic matter for energy) and to prevent build up, drinking troughs/cups should be inspected daily and cleaned out with a scrub brush at least weekly (more often if contaminated).[DM194]	**No**
158	**Do you have railings around the waterers to prevent animals from entering, defecating or urinating in the trough?[DQ185]** *Railings placed around waterers at 2 feet above the top edge of the trough will prevent animals from entering and decrease the risk of defecation or urination, which minimizes contamination of the drinking source.[DM195]	**No**

Question		Response
159	**Have you tested your water in the last year?[DQ186]** *Water can contain bacteria, nitrates, and other residues that could potentially cause illness in calves and cows and testing the water at least annually will provide a monitoring system so that steps can be taken to minimize exposure should a problem be identified.[DM196]	**No**
160	**Do you chlorinate your water for bacterial control?[DQ187]** *If bacteria are a problem or waterers get contaminated regularly, chlorination can help decrease the numbers of bacteria, thus decreasing the animals exposure to disease.[DM197]	**No**
161	**Do you limit livestock access to undesirable water sources (ponds, stagnant water, lagoons)?[DQ188]** *Water sources that are not monitored (ponds, cess pools, lagoons) have the potential to carry many disease causing organisms in them and animals should be restricted from access to it to decrease the risk of them consuming it or laying in it.[DM198]	**No**
162	**If water on your farm became unfit to drink, do you have a plan to provide good quality water to your livestock?[DQ189]** *Should a drought, pesticide spill, or well crack occur, establishing a plan to get water to your animals is essential; work with your local extension office to identify a water source (fire department, nearest town, neighbors) and make sure they also have a back-up plan in place. [DM199]	**No**
163	**Do you examine all feedstuffs closely for manure, mold, foreign material, and overall quality?[DQ190]** *Feedstuffs can become contaminated with manure, molds, foreign material (bones, baling wire) and should be examined before feeding because of the risk of exposing animals to disease causing organisms like Listeria, Salmonella, E. coli, and others or damaging their intestinal tract.[DM200]	**No**
164	**Do you prevent access to feed and feeding areas to dogs, cats, rodents, wildlife, birds, and other animals?[DQ191]** *Rodents, wildlife, even cats and dogs on farm carry disease causing organisms and should not be allowed near the feed or feeding areas to decrease the risk of exposure.[DM201] *Installing partitions and doors and keeping bagged feed in sealed containers are all methods to help keep out unwanted intruders (animal or human) from the feed or feeding area. [DM202]	**No**
165	**Are feed production/delivery steps being taken to minimize feed spillage? [DQ192]** *Spilled feed is an attractant to rodents, wildlife, birds, and other animals so steps should be taken throughout mixing and delivery to minimize this.[DM203] *Premixing large batches of dry feeds so it minimizes feed spillage from multiple piles is one step that can be taken; also, keeping feed bags/bunkers covered and the area around it cleaned up to minimize the attraction of wildlife is important to decrease the risk of disease spread.[DM204]	**No**

Question		Response
166	**If feed is spilled, is it picked up immediately?[DQ193]** *Spilled feed is an attractant to rodents, wildlife, birds, and other animals that carry diseases that can be spread to feeding areas, so feed should be picked/swept up immediately to minimize risk of exposure.[DM205]	**No**
167	**Does your feed/grain supplier test for mycotoxins?[DQ194]** *Mycotoxins pose a biological risk to animals that consume them, causing illness and even death in serious cases. Contact your feed supplier to see if they test for mycotoxins or purchase from sources that do.[DM206]	**No**
168	**Has your feed supplier explained their quality control program?[DQ195]** *Just as mixing feed on farm has a chance for error, so does purchased feed. Find out from your supplier what their quality control program consists of to ensure no ruminant proteins are used, and that contaminated feed or foreign material does not enter the system prior to it being delivered to your farm.[DM207]	**No**
169	**Does your feed supplier update you on any changes in their production process (new sources, milling changes)?[DQ196]** *It is important to find out from your feed supplier if any changes occur in their milling or mixing process. Consistency is important to growing calves and special attention may need to occur on farm regarding manure changes in adult cattle which may indicate a gastrointestinal change and potential disease course.[DM208]	**No**
170	**Are feed deliveries monitored to prevent inclusion of ruminant animal proteins into cattle rations?[DQ197]** *Ruminant protein feed products are illegal to feed to ruminants because of the risk of Bovine Spongiform Encephalopathy (BSE), so monitor feed deliveries to prevent their inclusion into cattle rations.[DM209]	**No**
171	**Are your pen entrances designed to prevent people from stepping into the feed bunk?[DQ198]** *Having a man-pass so that employees are able to get into and out of the pen without stepping into the feedbunk and contaminating it with manure and soil is essential to decreasing the risk of disease spread (Johne's, Salmonella, E. coli, etc), not to mention worker safety as an escape area.[DM210]	**No**
172	**Do you avoid feeding leftover/uneaten feed from lactating animals to young stock?[DQ199]** *Leftover or uneaten feed has been contaminated with saliva from adult cows, and potentially manure depending on the feeding set up, both of which can carry lots of disease organisms. This feed should not be fed to young stock intended for lactating purposes; the risk of disease transmission is too high.[DM211]	**No**

Question		Response
173	**Do you investigate animals that will not eat or do not consume all of their feed?[DQ200]** *Animals that refuse to eat or eat very little should be examined by removing them from the pen, restraining them in a chute, wearing gloves, and examining their mouth for signs of blisters, sores, or infected teeth; contact your veterinarian immediately if you see oral sores as this could be a highly contagious disease that you do not want spreading to other animals on farm.[DM212]	No
174	**Do you use different equipment for feed and manure handling?[DQ201]** *Equipment used for manure handling should not be used for mixing feed as the risk of disease causing organisms entering and mixing throughout the feed is high and could potentially expose every animal on farm to organisms like Johne's, Salmonella, E. coli, and others.[DM213]	No
175	**Are your manure-handling drive paths different from your feed mixing and delivery equipment drive paths?[DQ202]** *Feed or animal traffic paths should not cross manure hauling paths as manure can be laden with disease causing organisms that could subsequently be spread throughout the farm, exposing many animals.[DM214]	No
176	**If you use the same equipment for manure and feed, do you clean all manure off the bucket and tires and disinfect before using for feed?[DQ203]** *If the same equipment is used for scraping manure from the barn and moving/hauling feed, the entire bucket, all tires, and exposed areas must be washed off, scrubbed, and disinfected before handling feed because the risk of disease exposure is high; separate equipment or buckets is ideal to minimize this risk and avoid human error of not cleaning properly in between uses.[DM215]	No
177	**Do you prevent young animals from coming in contact with manure from older animals?[DQ204]** *Young stock are more susceptible to disease and it is important to minimize contact with manure from other livestock, especially older animals that might be carrying diseases this population has no immunity against.[DM216]	No
178	**Do you have an established internal parasite control program for replacement heifers?[DQ209]** *Internal parasites can affect growth rates and immune status, making animals more susceptible to diseases; control them throughout the year by sticking to an established control program designed with the help of your herd veterinarian.[DM100]	No
179	**Do you have an established external parasite control program for replacement heifers?[DQ210]** *External parasites can affect the growth rate, production, and health status of cattle making them more susceptible or even causing disease themselves; control them through an established treatment regimen (appropriate pour-on, back rubbers, ear tags).[DM101]	No

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Appendix 3. Prevention practices report

Operation/Client Description: PhD Demonstration Information
Assessment By: Dr. Danelle Bickett-Weddle
Assessment Date: 6/16/2007

Current Prevention Practices

Dairy: General

- Your livestock operation only has dairy cattle.[DP1]
- You know your neighbors.[DP2]
- You know what animals your neighbors have.[DP3]
- Cows are kept away from fence to fence contact with other livestock.[DP4]
- Calves are kept away from fence to fence contact with other livestock.[DP5]
- Nose to nose contact is limited between animals from different stages and/or age groups.[DP6]
- Fences are maintained to minimize animal crossover.[DP7]
- You minimize contact with wildlife.[DP8]
- You have deer-proof fences.[DP9]
- Gates that need to be locked are actually locked.[DP10]
- You have a designated visitor and employee vehicle parking area.[DP11]
- Your vehicle parking area is paved/concrete.[DP12]
- Your vehicle parking area is away from main animal traffic areas.[DP13]
- You have separate parking areas for employees vs. visitors.[DP14]
- Signs are posted and very visible restricting access to your facility to anyone not employed by the operation.[DP15]

These current prevention practices are not intended to be an all-inclusive list or to prioritize practices in any way. This information is provided based on responses to assessment questions and may not necessarily reflect an operation's everyday practices. Always consult your veterinarian for professional advice.

- All vehicles entering your operation are inspected for cleanliness.[DP16]
- You have separate vehicles for "on-farm" and "off-farm" use.[DP17]
- When using off-farm hauling vehicles, your loading/unloading areas are located at the perimeter of your operation.[DP18]
- You prohibit sharing equipment (including tractors) with other premises.[DP19]
- You encourage hoof trimmers to sanitize their chutes, tables, knives, and other equipment before coming onto your dairy.[DP20]
- You encourage milk truck drivers to disinfect their tires/wheel wells before coming onto the dairy. [DP21]
- Your bulk tank is located in such a way that milk truck drivers do not have any contact with animal pathways on farm.[DP22]
- When animals are rendered, the pick up area is located on the perimeter and away from all other entrances to your operation.[DP23]
- You have a fly control program.[DP24]
- When pesticides are used, the instructions are closely followed. [DP25]
- You have a rodent control program.[DP26]
- Rodent inspections (especially at night) are performed often to evaluate infestation levels.[DP27]
- You have a set schedule and designated person to check all pest control programs to ensure they are kept current.[DP28]
- You hire a professional pest control person to maintain an effective pest management system. [DP29]
- There is a three foot weed-free graveled perimeter around all your buildings (for rodent control). [DP30]

- The gravel (rock size) used for building perimeters is at least 1 inch in diameter and at least 1/2 foot deep.[DP31]
- Steps are being taken to minimize bird contact and nesting in your operation.[DP32]
- Visitors or sales people are required to be authorized prior to entering your premise.[DP33]
- You require visitors to sign in and disclose their last known cattle contact.[DP34]
- You limit access of visitors who have recently been to foreign countries.[DP35]
- You have foreign travel guidelines for your employees and family members.[DP36]
- Everyone who enters your operation (employees, service personnel, visitors) know and understand your BRM protocols.[DP37]
- You require everyone to wash their hands with soap and water every time before entering your facility.[DP38]
- You minimize animal contact with anyone entering your facility.[DP39]
- You require clean clothes on everyone entering your operation (visitors, service personnel).[DP40]
- You provide clean clothes for everyone entering your operation (visitors, service personnel).[DP41]
- You require clean footwear on everyone entering your operation (visitors, service personnel).[DP42]
- You provide clean boots (rubber/disposable) for everyone entering your operation.[DP43]
- When visitors have their own boots, you require cleaning and disinfecting them at your facility before entering.[DP44]
- You provide a boot bath or trash receptacle at the entrance/exit to your operation for ease of cleaning/disposing of protective footwear.[DP45]

- You have a water hose to wash off organic matter from boots near the boot bath.[DP46]
- You have a brush to scrub off organic matter from boots near the boot bath.[DP47]
- Boot baths are maintained properly (changed when organic matter contaminates it or at least daily).[DP48]
- You require everyone to wash their hands with soap and water every time before entering your facility.[DP49]
- Coveralls (or any other special attire) are required to be worn by employees while working with cattle.[DP52]
- Employees are trained to know when their clothing is considered "dirty" enough to require changing.[DP53]
- Your work/farm clothing is restricted from being worn outside of your operation.[DP54]
- You request that your employees avoid contact with livestock outside of your operation.[DP55]
- Employees are required to report ownership of offsite owned livestock to management.[DP56]
- Employees are required to change clothing when moving into special areas of the farm such as the maternity and calf areas.[DP57]
- Laundering facilities are available on farm for washing work clothes.[DP58]
- Laundering facilities are restricted for use of work clothes only.[DP59]
- Employees are required to wear latex/nitrile gloves when working with animals.[DP60]
- Protocols have been established to determine how often latex/nitrile gloves need to be changed.[DP61]
- Employees are required to change their latex/nitride gloves when moving to a different area of the operation.[DP62]

- Work boots are restricted from being worn in the public traffic/office areas.[DP63]

- Employees are required to clean and disinfect their boots when moving into special areas of the farm such as the maternity and calf areas.[DP64]

- Employees have easy access to hand washing stations or hand sanitizers.[DP65]

- There are requirements for how often or when hands need to be washed.[DP66]

- Someone regularly (weekly) monitors soap and towels in hand washing areas.[DP67]

- You have signs posted in restrooms and the milkroom promoting hand washing.[DP68]

- Employees have access to toilet facilities at all times.[DP69]

- You have restrictions on where food and drinks are allowed on your premise.[DP70]

- You have a separate refrigerator for human food and drinks.[DP71]

- All animals are individually identified.[DP72]

- Treatment records are kept for all animals.[DP73]

- Treatment records are kept for lactating heifers.[DP74]

- Treatment records are kept for dry cows/pre-fresh animals.[DP75]

- Treatment records are kept for replacement animals.[DP76]

- All animals are inspected daily for signs of illness.[DP77]

- You have an established program for everyone to be able to recognize and report diseases. [DP78]
- When doing chores, you move from "clean" younger animals to "older" animals, to "dirty"/sick animals, and finally isolation animals.[DP79]
- Animals that are not going to recover are euthanized humanely and promptly.[DP80]
- Dead animals are removed from the operation immediately after euthanasia.[DP81]
- Dead animals are properly disposed of (rendered, composted).[DP82]
- The dead pile is protected from predators.[DP83]
- You have a veterinarian necropsy all animals that die from undetermined causes.[DP84]
- Clean medical equipment (balling guns, obstetrical equipment, syringes) is stored in a dry, dust free space.[DP85]
- Non-refrigerated vaccines and antibiotics are kept out of sunlight.[DP86]
- You regularly monitor your medicine/vaccine refrigerator for proper cooling temperatures (36-46°F).[DP87]
- You restrict who has access to medications and vaccines used on the dairy.[DP88]
- You prohibit the reuse of disposable supplies (mastitis tubes, needles).[DP89]
- You change OB/AI sleeves after each cow.[DP90]
- You have an established internal parasite control program for each production stage.[DP91]
- You have an established external parasite control program for each production stage.[DP92]

- There is a mound or other dry place where animals can lay down if outside.[DP93]
- During the dry season, you are able to control dust in dry lots.[DP94]
- The dry lot area is regularly maintained to prevent manure buildup and areas of stagnant water.[DP95]
- Alley ways are kept clean (scraped or flushed at least one time daily).[DP96]
- Stalls are kept clean (scraped at least on time daily).[DP97]
- Stalls are kept dry (refilled with bedding).[DP98]
- You are able to regulate your indoor ventilation based on seasons (fans, curtain side walls, sprinklers).[DP99]
- The indoor humidity is equal to or less than the outdoor humidity in warm weather months.[DP100]
- There is a humidistat in each barn.[DP101]
- You separate sick cows (potentially contagious) from healthy cows as soon as possible.[DP102]
- You have an isolation area for sick animals on farm.[DP103]
- You have a quarantine area for newly introduced animals.[DP104]
- You have written/posted protocols regarding when sick/treated animals can be returned to the herd.[DP108]
- You have written standard operating procedures (SOPs) for milking.[DP117]
- The same person trains all the personnel on the milking procedure.[DP118]

- Milkers wear gloves.[DP119]
- Cows udders/teats are clean before milking units are attached.[DP120]
- Pre-milking teat dips are used.[DP122]
- The pre-dip solution is allowed to have at least 15-20 seconds of contact time.[DP123]
- Cows' teats are wiped completely dry before attaching the milking unit.[DP124]
- You use single service (washable/disposable) towels.[DP125]
- The milking unit is attached within 60-120 seconds after first touching the cow's teat.[DP126]
- The milking unit is monitored for liner slips throughout milking.[DP127]
- The milking vacuum is always shut off prior to removing the milking unit.[DP128]
- Post-milking teat dips are used.[DP129]
- Workers are trained to dispose of used dip solutions and not put it back in the main container.[DP130]
- Dip cups are emptied, washed, and allowed to dry out before refilling.[DP131]
- Cows are kept on their feet for at least 30-45 minutes after milking to allow keratin plug formation in the teat canal.[DP132]
- You have regular maintenance schedules for your milking equipment.[DP133]
- Your somatic cell count is routinely under 200,000.[DP134]

- Bulk tank somatic cell counts are routinely monitored.[DP135]
- A CMT paddle is used on individual cows to monitor for mastitis.[DP136]
- Workers wash their hands with soap and water after milking/treating mastitic cows.[DP137]
- Milk from individual cows with mastitis is cultured for contagious organisms.[DP138]
- The bulk tank is routinely monitored for contagious organisms by doing cultures.[DP139]
- Chronic mastitis animals are removed from your operation as soon as possible.[DP140]
- Milking equipment is washed, sanitized and disinfected between EVERY milking.[DP141]
- Milking equipment is washed, sanitized and disinfected at least once every 24 hours.[DP142]
- Food for human consumption is prohibited in the parlor.[DP143]
- You have an established internal parasite control program for lactating cattle.[DP144]
- You have an established external parasite control program for lactating cattle.[DP145]
- Calves are removed from mothers at birth before allowing them to nurse.[DP155]
- You prevent calves from nursing cows when they are not immediately removed at birth.[DP156]
- Maternity equipment is cleaned and disinfected immediately after use.[DP158]
- Maternity equipment is protected from contamination between uses.[DP159]

- The cow's udder is cleaned before collecting colostrum.[DP160]
- Colostrum is collected within the first 2 hours after calving.[DP161]
- A colostrometer is used to determine poor versus good quality colostrum.[DP162]
- You immediately refrigerate colostrum that is not going to be fed for 2-4 hours in a sealed, single use container.[DP163]
- You immediately freeze your colostrum if it will be stored for more than 24 hours in a labeled, sealed, single use container.[DP164]
- You always use the best quality colostrum for first time feedings.[DP165]
- Only single source colostrum is used.[DP166]
- You only use colostrum from test negative cows (BLV and Johne's).[DP167]
- You give newborns 3/4 to 1 gallon of colostrum within the first six hours of life.[DP168]
- You give a second dose (1/2 to 3/4 gallon) of colostrum 12 hours later.[DP169]
- Milk replacer is stored in a tightly sealed container to prevent contamination[DP170]
- Waste milk is pasteurized before feeding to calves.[DP171]
- You clean all buckets, bottles, and nipples after each feeding.[DP172]
- You clean and sanitize all milk replacer mixing and handling equipment after each feeding. [DP173]
- Coccidiostats are a regular part of your calf feeding program.[DP174]

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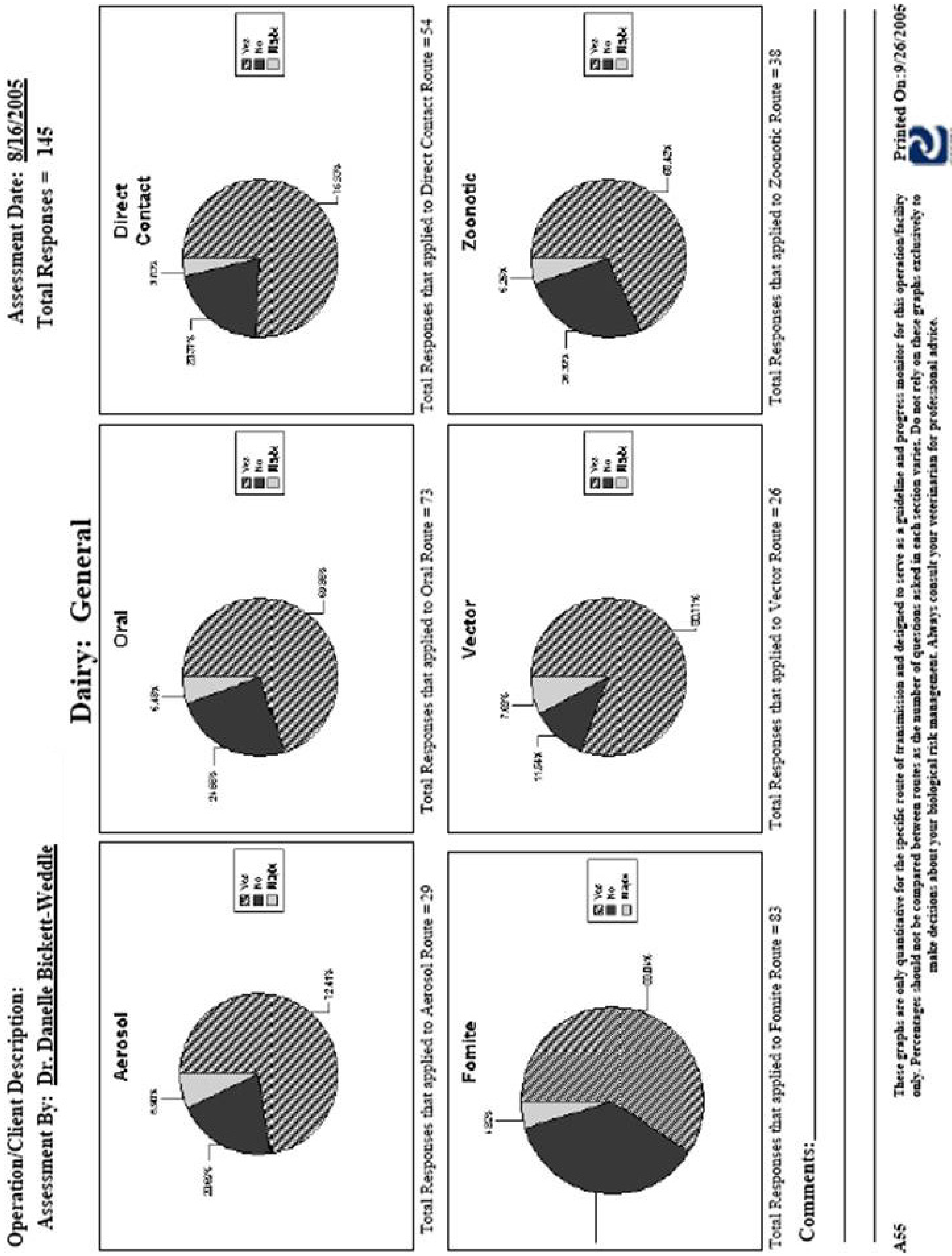
- Individual calf hutches spaced far enough apart to prevent direct contact are used for newborn calves.[DP175]
- You thoroughly clean, disinfect and allow all calf hutches to completely dry between uses. [DP177]
- All abortions or at least those above a set threshold are investigated.[DP180]
- You have an established internal parasite control program for dry cows/pre-fresh animals. [DP181]
- You have an established external parasite control program for dry cows/pre-fresh animals. [DP182]
- Animals have access to clean, fresh water all day.[DP183]
- You frequently clean water troughs/cups (at least weekly).[DP184]
- There are railings around the waterers to prevent animals from entering, defecating, or urinating in the trough.[DP185]
- You have tested your water in the last year.[DP186]
- Your water is chlorinated for bacterial control.[DP187]
- Livestock are limited from having access to undesirable water sources (ponds, stagnant water, lagoons).[DP188]
- You have a plan to provide good quality water to your livestock if water on your farm became unfit to drink.[DP189]
- You examine all feedstuffs closely for manure, mold, foreign material, and overall quality.[DP190]
- You prevent access to feed and feeding areas to dogs, cats, rodents, wildlife, birds, and other animals.[DP191]
- Feed production/delivery steps are being taken to minimize feed spillage.[DP192]

- Feed is picked up immediately when spilled.[DP193]
- Your feed/grain supplier tests for mycotoxins.[DP194]
- Your feed supplier has explained their quality control program to you.[DP195]
- Your feed supplier updates you on any changes in their production process (new sources, milling changes).[DP196]
- Feed deliveries are monitored to prevent inclusion of ruminant animal proteins into cattle rations.[DP197]
- Pen entrances are designed to prevent people from stepping in to the feed bunk.[DP198]
- Leftover/uneaten feed from lactating animals is not fed to young stock.[DP199]
- You investigate animals that will not eat or do not consume all of their feed.[DP200]
- Different equipment is used for feed and manure handling.[DP201]
- Manure-handling drive paths are different from your feed mixing and delivery equipment drive paths.[DP202]
- You clean all manure off the bucket and tires and disinfect before using for hauling feed.[DP203]
- You prevent young animals from coming in contact with manure from older animals.[DP204]
- You have an established external parasite control program for replacement heifers.[DP209]
- You have an established internal parasite control program for replacement heifers.[DP210]

Appendix 4. Route of transmission graph report



Appendix 5. All responses report

Operation/Client Description: PhD Demonstration Information
Assessment By: Dr. Danelle Bickett-Weddle
Assessment Date: 6/16/2007
Assessment Name:

All Questions & Responses

Dairy: General

Question		Response
1	Are the only animal species on your operation dairy cattle? [DQ1]	No
2	Do you know your neighbors? [DQ2]	No
3	Do you know what animals your neighbors have? [DQ3]	No
4	Are your cows kept away from fence to fence contact with other livestock? [DQ4]	No
5	Are your calves kept away from fence to fence contact with other livestock? [DQ5]	No
6	Do you limit nose to nose contact between animals with different vaccination status and/or age groups? [DQ6]	No
7	Are fences maintained to minimize animal crossover? [DQ7]	No
8	Do you try to minimize wildlife contact with animals on your farm? [DQ8]	No
9	Do you have deer-proof fences? [DQ9]	No
10	Are gates that need to be locked actually locked? [DQ10]	No
11	Do you have a designated visitor and employee vehicle parking area? [DQ11]	No
12	Is your vehicle parking area paved/concrete? [DQ12]	No
13	Is your vehicle parking area away from main animal traffic areas? [DQ13]	No
14	Do you have separate parking areas for employees vs. visitors? [DQ14]	No
15	Are signs posted and very visible restricting access to your facility to anyone not employed by the operation? [DQ15]	No
16	Are all vehicles entering your operation inspected for cleanliness? [DQ16]	No
17	Do you have separate vehicles for "on-farm" and "off-farm" use? [DQ17]	No
18	When using off-farm hauling vehicles, are your loading/unloading areas located at the perimeter of your operation? [DQ18]	No
19	Do you prohibit sharing equipment (including tractors, trailers) with other premises? [DQ19]	No
20	Do you encourage hoof trimmers to sanitize their chutes, tables, knives and other equipment before coming onto the dairy? [DQ20]	No
21	Do you encourage milk truck drivers to disinfect their tires/wheel wells before coming onto the dairy? [DQ21]	No
22	Is your bulk tank located in such a way that milk truck drivers do not have any contact with animal pathways on farm? [DQ22]	No
23	If animals are rendered, is the pickup area located on the perimeter and away from all other entrances to your operation? [DQ23]	No
24	Do you have a fly control program? [DQ24]	No
25	If pesticides are used, are the label instructions closely followed? [DQ25]	No
26	Do you have a rodent control program? [DQ26]	No

Question		Response
27	Are rodent inspections (especially at night) performed often to evaluate infestation levels? [DQ27]	No
28	Do you have a set schedule and designated person to check all pest control programs to ensure they are kept current? [DQ28]	No
29	Do you hire a professional pest control person to maintain an effective pest management system? [DQ29]	No
30	Is there a three foot, weed-free, graveled perimeter around all your buildings (for rodent control)? [DQ30]	No
31	Is the gravel (rock size) used for building perimeters at least 1 inch in diameter and at least 1/2 foot deep to minimize weed/grass growth? [DQ31]	No
32	Are steps being taken to minimize bird contact and nesting in your operation? [DQ32]	No
33	Are visitors or sales people required to be authorized prior to entering your premises? [DQ33]	No
34	Do you require visitors to sign in and disclose their last known cattle contact? [DQ34]	No
35	Do you limit access of visitors who have recently been to foreign countries? [DQ35]	No
36	Do you have foreign travel guidelines for your employees and family members? [DQ36]	No
37	Does everyone who enters your operation (employees, service personnel, visitors) know and understand your BRM protocols? [DQ37]	No
38	Do you require everyone to wash their hands with soap and water every time before entering your facility? [DQ38]	No
39	Do you minimize animal contact with anyone entering your operation? [DQ39]	No
40	Do you require clean clothes on everyone entering your operation (visitors, service personnel)? [DQ40]	No
41	Do you provide clean clothes for everyone entering your operation (coveralls, gloves)? [DQ41]	No
42	Do you require clean footwear on everyone entering your operation (visitors, service personnel)? [DQ42]	No
43	Do you provide clean boots (rubber/disposable) for everyone entering your operation? [DQ43]	No
44	If visitors have their own boots, do you require cleaning and disinfecting them at your facility before entering? [DQ44]	No
45	Do you provide a boot bath or trash receptacle at the entrance/exit to your operation for ease of cleaning/disposing of footwear? [DQ45]	No
46	Do you have a water hose to wash off organic matter from boots near the boot bath? [DQ46]	No
47	Do you have a brush to scrub off organic matter from boots near the boot bath? [DQ47]	No

Question		Response
48	Are boot baths maintained properly (changed when organic matter contaminates it or at least daily)? [DQ48]	No
49	Do you require everyone to wash their hands with soap and water every time before leaving your facility? [DQ49]	No
50	Are coveralls (or any other special attire) required to be worn by people handling your animals? [DQ52]	No
51	Are employees trained to know when their clothing is considered "dirty" enough to require changing? [DQ53]	No
52	Is your work/farm clothing restricted from being worn outside of your operation? [DQ54]	No
53	Do you request that your employees avoid contact with livestock outside of your operation? [DQ55]	No
54	Do you require employees to report ownership of offsite owned livestock? [DQ56]	No
55	Are employees required to change clothing when moving into special areas of the farm such as the maternity and calf areas? [DQ57]	No
56	Are laundering facilities available on farm for washing work clothes? [DQ58]	No
57	Are laundering facilities restricted for use of work clothes only? [DQ59]	No
58	Do you require people handling sick animals to wear latex/nitrile gloves? [DQ60]	No
59	Have protocols been established to determine how often latex/nitrile gloves need to be changed? [DQ61]	No
60	Are employees required to change their latex/nitrile gloves when moving to a different area of the operation? [DQ62]	No
61	Are work boots restricted from being worn in the public traffic/office areas? [DQ63]	No
62	Are employees required to clean and disinfect their boots when moving into special areas of the farm such as the maternity and calf areas? [DQ64]	No
63	Do employees have easy access to hand washing stations or hand sanitizers? [DQ65]	No
64	Are there requirements for how often or when hands need to be washed? [DQ66]	No
65	Does someone regularly (weekly) monitor soap and towels in handwashing areas? [DQ67]	No
66	Do you have signs posted in restrooms and the milkroom promoting hand washing? [DQ68]	No
67	Do employees have access to toilet facilities at all times? [DQ69]	No
68	Do you have restrictions on where food and drinks are allowed on your premise? [DQ70]	No
69	Do you have a separate refrigerator for human food and drinks? [DQ71]	No
70	Are all animals individually identified? [DQ72]	No
71	Do you keep treatment records for all animals? [DQ73]	No

Question		Response
72	Do you keep treatment records for lactating animals? [DQ74]	No
73	Do you keep treatment records for all replacements? [DQ75]	No
74	Do you keep treatment records for dry cows/pre-fresh animals? [DQ76]	No
75	Are all animals inspected daily for signs of illness? [DQ77]	No
76	Do you have an established program for everyone to be able to recognize and report diseases? [DQ78]	No
77	During chores, do you move from youngest to oldest and handle sick animals last? [DQ79]	No
78	Are animals that are not going to recover euthanized humanely and promptly? [DQ80]	No
79	Are dead animals removed from the operation immediately after euthanasia? [DQ81]	No
80	Are dead animals properly disposed of (rendered, composted)? [DQ82]	No
81	If animals are rendered, is the dead pile protected from predators? [DQ83]	No
82	Do you have a veterinarian necropsy all animals that die from undetermined causes? [DQ84]	No
83	After they are cleaned, is the medical equipment (balling guns, esophageal tubes, syringes) stored in a dry, dust free place? [DQ85]	No
84	Are non-refrigerated vaccines and antibiotics kept out of sunlight? [DQ86]	No
85	Do you regularly monitor your medicine/vaccine refrigerator for proper cooling temperatures (36-46°F)? [DQ87]	No
86	Do you restrict who has access to medications and vaccines used on the dairy? [DQ88]	No
87	Do you prohibit the reuse of disposable supplies (mastitis tubes, needles)? [DQ89]	No
88	Do you change OB/AI sleeves after each cow? [DQ90]	No
89	Do you have an established internal parasite control program for each production stage? [DQ91]	No
90	Do you have an established external parasite control program for each production stage? [DQ92]	No
91	Is there a mound or other dry place where animals can lay down when outside? [DQ93]	No
92	During the dry season, are you able to control dust in dry lots? [DQ94]	No
93	Is the dry lot area regularly maintained to prevent manure buildup and areas of stagnant water? [DQ95]	No
94	Do you keep your alley ways clean (scraped or flushed at least one time daily)? [DQ96]	No
95	Do you keep your stalls clean (scraped at least one time daily)? [DQ97]	No
96	Do you keep your stalls dry (refilled with bedding)? [DQ98]	No
97	Are you able to regulate your indoor ventilation based on seasons (fans, curtain side walls, sprinklers)? [DQ99]	No

Question		Response
98	Is your indoor humidity equal to or less than the outdoor humidity in warm weather months? [DQ100]	No
99	Do you have a humidistat in each barn? [DQ101]	No
100	Do you separate sick cows (potentially contagious) from healthy cows ASAP? [DQ102]	No
101	Do you have an isolation area for sick animals on farm? [DQ103]	No
102	Do you have an area used only for quarantine for newly introduced animals? [DQ104]	No
103	Do you have written/posted protocols regarding when sick/treated animals can be returned to the herd? [DQ108]	No
104	Do you have written standard operating procedures (SOPs) for milking? [DQ117]	No
105	Does the same person train all the personnel on the milking procedure? [DQ118]	No
106	Do milkers wear gloves? [DQ119]	No
107	Are cows' udders/teats clean before attaching the milking units? [DQ120]	No
108	Do you use pre-milking teat dips? [DQ122]	No
109	Is the pre-dip solution allowed to have at least 15-20 seconds of contact time? [DQ123]	No
110	Are cows' teats wiped completely dry before attaching the milking unit? [DQ124]	No
111	Do you use single service (washable/disposable) towels? [DQ125]	No
112	Is the milking unit attached within 60-120 seconds after first touching the cow's teat? [DQ126]	No
113	Is the milking unit monitored for liner slips throughout milking? [DQ127]	No
114	Is the milking vacuum always shut off prior to removing the milking unit? [DQ128]	No
115	Do you use post-milking teat dips? [DQ129]	No
116	Are workers trained to dispose of used dip solutions and not pour it back into the main container? [DQ130]	No
117	Are dip cups emptied, washed, and allowed to dry out before refilling? [DQ131]	No
118	Are cows kept on their feet for at least 30-45 minutes after milking to allow keratin plug formation in the teat canal? [DQ132]	No
119	Do you have regular maintenance schedules for your milking equipment? [DQ133]	No
120	Is your somatic cell count routinely under 200,000? [DQ134]	No
121	Do you do routinely monitor bulk tank somatic cell counts? [DQ135]	No
122	Do you use a CMT paddle on individual cows to monitor for mastitis? [DQ136]	No
123	Do workers wash their hands with soap and water after milking/treating mastitic cows? [DQ137]	No
124	Do you culture milk from individual cows with mastitis for contagious organisms? [DQ138]	No

Question		Response
125	Do you routinely monitor bulk tank cultures for contagious organisms? [DQ139]	No
126	Are chronic mastitis animals removed from your operation ASAP? [DQ140]	No
127	Is milking equipment washed, sanitized and disinfected between EVERY milking? [DQ141]	No
128	Is milking equipment washed, sanitized and disinfected at least once every 24 hours? [DQ142]	No
129	Is food for human consumption prohibited in the parlor? [DQ143]	No
130	Do you have an established internal parasite control program for lactating cattle? [DQ144]	No
131	Do you have an established external parasite control program for lactating cattle? [DQ145]	No
132	Do you remove calves from mothers at birth, not allowing them to nurse? [DQ155]	No
133	If you do not immediately remove newborn calves at birth, do you prevent calves from nursing cows? [DQ156]	No
134	Is maternity equipment cleaned and disinfected immediately after use? [DQ158]	No
135	Is maternity equipment protected from contamination between uses? [DQ159]	No
136	Do you clean the cow's udder before collecting colostrum? [DQ160]	No
137	Do you collect colostrum within the first 2 hours after calving? [DQ161]	No
138	Do you use a colostrometer to determine poor versus good quality colostrum? [DQ162]	No
139	Do you immediately refrigerate colostrum that is not going to be fed for 2-4 hours in a sealed, single use container? [DQ163]	No
140	Do you immediately freeze your colostrum if it will be stored for more than 24 hours in a labeled, sealed, single use container? [DQ164]	No
141	Do you always use the best quality colostrum for first time feedings? [DQ165]	No
142	Do you only use single source colostrum, not pooled from multiple cows? [DQ166]	No
143	Do you only use colostrum from test negative cows (BLV and Johne's)? [DQ167]	No
144	Do you give newborns 3/4 to 1 gallon of colostrum within the first six hours of life? [DQ168]	No
145	Do you give a second dose (1/2 to 3/4 gallon) of colostrum 12 hours later? [DQ169]	No
146	Do you store your milk replacer in a tightly sealed container to prevent contamination? [DQ170]	No
147	Do you pasteurize waste milk before feeding to calves? [DQ171]	No
148	Do you clean all buckets, bottles, and nipples after each feeding? [DQ172]	No

Question		Response
149	Do you clean and sanitize all milk replacer mixing and handling equipment after each feeding? [DQ173]	No
150	Are coccidiostats a regular part of your calf feeding program? [DQ174]	No
151	Do you utilize individual calf housing for newborn calves and ensure there is no direct contact between them? [DQ175]	No
152	Do you thoroughly clean, disinfect and allow all calf hutches to completely dry between uses? [DQ177]	No
153	Do you investigate all abortions or at least those above a set threshold? [DQ180]	No
154	Do you have an established internal parasite control program for dry cows/pre-fresh animals? [DQ181]	No
155	Do you have an established external parasite control program for dry cows/pre-fresh animals? [DQ182]	No
156	Do animals have access to clean, fresh water all day? [DQ183]	No
157	Do you clean water troughs/cups frequently (at least weekly)? [DQ184]	No
158	Do you have railings around the waterers to prevent animals from entering, defecating or urinating in the trough? [DQ185]	No
159	Have you tested your water in the last year? [DQ186]	No
160	Do you chlorinate your water for bacterial control? [DQ187]	No
161	Do you limit livestock access to undesirable water sources (ponds, stagnant water, lagoons)? [DQ188]	No
162	If water on your farm became unfit to drink, do you have a plan to provide good quality water to your livestock? [DQ189]	No
163	Do you examine all feedstuffs closely for manure, mold, foreign material, and overall quality? [DQ190]	No
164	Do you prevent access to feed and feeding areas to dogs, cats, rodents, wildlife, birds, and other animals? [DQ191]	No
165	Are feed production/delivery steps being taken to minimize feed spillage? [DQ192]	No
166	If feed is spilled, is it picked up immediately? [DQ193]	No
167	Does your feed/grain supplier test for mycotoxins? [DQ194]	No
168	Has your feed supplier explained their quality control program? [DQ195]	No
169	Does your feed supplier update you on any changes in their production process (new sources, milling changes)? [DQ196]	No
170	Are feed deliveries monitored to prevent inclusion of ruminant animal proteins into cattle rations? [DQ197]	No
171	Are your pen entrances designed to prevent people from stepping into the feed bunk? [DQ198]	No
172	Do you avoid feeding leftover/uneaten feed from lactating animals to young stock (less than 12 months old)? [DQ199]	No
173	Do you investigate animals that will not eat or do not consume all of their feed? [DQ200]	No
174	Do you use different equipment for feed and manure handling? [DQ201]	No

Question		Response
175	Are your manure-handling drive paths different from your feed mixing and delivery equipment drive paths? [DQ202]	No
176	If you use the same equipment for manure and feed, do you clean all manure off the bucket and tires and disinfect before using for feed? [DQ203]	No
177	Do you prevent young animals from coming in contact with manure from older animals? [DQ204]	No
178	Do you have an established internal parasite control program for replacement heifers? [DQ209]	No
179	Do you have an established external parasite control program for replacement heifers? [DQ210]	No

Appendix 6. Recommendations for conducting BRM assessments

Preparing for the on-farm assessment…

When making the appointment, allow an hour to an hour and a half to go through everything (pre-assessment questionnaire and general questions). This way neither you nor the producer will feel rushed.

Once you have selected your farms to interview, create a farm "code" for each. That will be entered into the online database on written on the Pre-Assessment Questionnaire.

Take a clipboard and extra pens/pencils. I always take a binder clip to clip the loose end of the pages to the clipboard in case it's windy. (It is usually windy in Iowa…keeps things from blowing all over!) This will make the process easier.

If possible, obtain a copy of their herd summary data (DHIA report). To ensure client confidentiality, blacken out their farm name, contact info, and herd code while they are present and write the farm code you have assigned them on it. This will let them see we are protecting their identity.

Mark the Pre-Assessment questionnaire with your initials in the box- this will help us in case we have a question about an answer/comment or can't read the writing

Complete the *entire* Pre-Assessment questionnaire. This information will be compared to the Yes/No/Maybe responses on the General CA question set for correlations. This will take 7-10 minutes.

When asking questions…

Walk around the farm with the person. Often times the person you are interviewing will answer what they think is being done, not what is actually being done. By walking around to the different areas, you can make them aware of actual protocols on farm. That can be an educational experience in its own right sometimes.

Read the question EXACTLY as it is written. Do not ad lib or leave words out. Previous assessments have shown that if you do not ask it as it is written, you will not get an accurate response. <u>This is critical</u>.

Take your time and make sure the person you are questioning has time to respond. If they want to come back to a question, as they "suddenly thought of something else" that is fine. Indicate on the sheet that the question was revisited and write in the additional information.

Do not answer for them. Even if you have been going there for a million years, let them respond to your answers. Often times this is a learning experience for the assessor. Our assumptions must not get in the way of the question/answer process.

If the person appears unsure about how to respond, just mark Maybe. I have learned that if they are not 100% certain that they do something, they hem and haw a bit- body language can tell you a lot. Unless you are witnessing a true “No” response with your own eyes, just mark Maybe.

When in doubt, write down comments about the question. If you ask the question and there is confusion and you are not able to further explain, that is fine. Just write a comment about it so that we know the question needs to be improved or more information is needed.

Since this is a snapshot in time, and the protocols you are asking about encompass more than one day’s actions, **their response can reflect what is typically done on that farm**. For instance, “do you have a fly control program?” If they say yes we do, but you notice a million flies on farm, you may want to include a comment about that. Or if one area of the farm is particularly bad (calf hotels/hutches), indicate that in your comments. It can be an educational point for them later…something they need to address to minimize risk of disease spread. If they elaborate and say the spray company is due out tomorrow, or they sprayed and then it rained, those are valid reasons for out of control flies. If they appear to recognize fly control is important on their farm and they are making an attempt to control them that is a “Yes” response. If they are nonchalant about it, it typically means they don’t consider it a risk and don’t attempt to control it. That is a “No” response.

If you **skip a question because it didn’t apply**, mark N/A in the white space next to the question.

If you **skip a question because you forgo**t to ask it, and realize it later while on farm, ask it then. If you realize after you have left the farm, mark SKIPPED in the white space next to the question.

When in doubt, write down comments about the question. If you ask the question and there is confusion and you are not able to further explain, that is fine. Just write a comment about it so that we know the question needs to be improved or more information is needed.

Smile, relax and have a great time learning a little bit about the infectious disease control procedures on California dairies!

I sincerely appreciate your dedication to the project and look forward to working with you!

Danelle Bickett-Weddle, DVM, MPH
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Appendix 7. Pre-assessment questionnaire

Dairy Biological Risk Management
Pre-Assessment Questionnaire

Farm Code Name:	**Date**
County and State:	
Assessment by:	

1. Nature of operation at **THIS** location. **(Mark all that apply):**

Animal Type		**# Head**	**Housing Type (CIRCLE)**	**Individual or Group- # Head**
Replacement Heifers	Pre-Weaned 0 - 2 months		Barn Dry lot Hutch Pen-solid Pen-mesh panels	
	Weaned 3 - 8 months		Hutch Dry lot Pen Pasture	
	Pre-Bred 9 - 12 months		Barn Dry lot Pasture	
	Bred 13 - 22 months		Barn Dry lot Pasture	
Dry Cows/Pre-Fresh 23 - 24 months			Barn Dry lot Pasture	
Lactating			Bedded pack Dry lot Free stalls only Free stall with access to exercise lot Pasture	
2. Breed(s)				

Dairy Biological Risk Management Pre-Assessment Questionnaire

3. Herd Data (production, quality, cull) (copy of Herd Summary sheet if possible)	Projected ME 305 day ________ Standardized 150d milk ________ Days in milk _________ SCC __________ Cull rate ____________
4. Milking frequency:	Lactating herd: ❑ 2 times a day ❑ 3 times a day ❑ 4 times a day Fresh cows: ❑ 2 times a day ❑ 3 times a day ❑ 4 times a day ❑ 6 times a day
5. Do you use bST?	❑ Yes ❑ No If Yes, % of herd? Given per label directions? ❑ Yes ❑ No (Start at 63 DIM, given at 14 day intervals)
6. Do you keep individual health/ prevention records on your animals? **If Yes**, please check all that apply and describe the type of records you keep:	❑ Yes ❑ No ❑ DC 305 ❑ DHIA – monthly ❑ DHIA – bi-monthly ❑ DHIA – plus ❑ Production (on-farm software) ❑ SCC testing only ❑ Treatments ❑ Vaccinations ❑ Other_____________________
7. How many visitors (veterinarian, milk truck, feed delivery, etc) enter your facility **weekly**?	❑ 0-9 ❑ 50-59 ❑ 10-19 ❑ 60-69 ❑ 20-29 ❑ 70-79 ❑ 30-39 ❑ 80-89 ❑ 40-49 ❑ 90+
8. Do you have a protocol for visitors (visitor log, coveralls, boots, boot bath, etc)? **If Yes**, please describe.	❑ Yes ❑ No

Dairy Biological Risk Management Pre-Assessment Questionnaire

9. How often do animals leave and re-enter the herd (shows, vet clinic, embryo transfer, etc):	❑ Never ❑ Rarely (1-2 times per year) ❑ Sometimes (3-6 times per year) ❑ Frequently (monthly) ❑ Other____________________
10. How often do you bring in new animals? Please give number, time frame, and type.	❑ Number? ____________________ ❑ per week ❑ per month ❑ per year ❑ Type? ❑ Heifers (0-12 months) ❑ Bred Heifers (13-22 months) ❑ Dry Cows ❑ Lactating ❑ Other____________________
11. Do you have isolation facilities? **If Yes,** how long are animals kept here on average? Are any tests for various diseases done while in isolation (mastitis, Johne's, BVD)? **If Yes,** for what?	❑ Yes ❑ No ❑ Yes ❑ No
12. What disease(s) are you most worried about occurring at your facility?	
13. What do you perceive as the biggest disease risk/challenge(s) for your facility?	
14. Are you interested in learning about additional resources to help you manage those risks?	❑ Yes ❑ No

Appendix 8. Assessment questionnaire

Operation/Client Description: ______________________________

Assessment By: ______________________________

Assessment Date: ______________________________

General CA Section

Question #	Yes	No	Maybe		Comments
1				Are your cows kept away from fence to fence contact with other livestock? [DQ4]	
2				Do you limit nose to nose contact between animals from different stages and/or age groups? [DQ6]	
3				Do you have a designated visitor and employee vehicle parking area? [DQ11]	
4				Are signs posted and very visible restricting access to your facility to anyone not employed by the operation? [DQ15]	
5				If animals are rendered, is the pickup area located on the perimeter and away from all other entrances to your operation? [DQ23]	
6				Do you have a fly control program? [DQ24]	
7				Do you have a set schedule and designated person to check all pest control programs to ensure they are kept current? [DQ28]	
8				Do you require visitors to sign in and disclose their last known cattle contact? [DQ34]	
9				Do you minimize animal contact with anyone entering your operation? [DQ39]	
10				Do you require clean clothes on everyone entering your operation (visitors, service personnel)? [DQ40]	
11				Do you require clean footwear on everyone entering your operation (visitors, service personnel)? [DQ42]	
12				Do you request that your employees avoid contact with livestock outside of your operation? [DQ55]	
13				Are employees required to change clothing when moving into special areas of the farm such as the maternity and calf areas? [DQ57]	
14				Are employees required to clean and disinfect their boots when moving into special areas of the farm such as the maternity and calf areas? [DQ64]	
15				Do you keep treatment records for all animals? [DQ73]	

Question #	Yes	No	Maybe		Comments
16				Are all animals inspected daily for signs of illness? [DQ77]	
17				During chores, do you move from "clean" younger animals to "older" animals, to "dirty"/sick animals, and finally isolation animals? [DQ79]	
18				Are animals that are not going to recover euthanized humanely and promptly? [DQ80]	
19				Do you have a veterinarian necropsy all animals that die from undetermined causes? [DQ84]	
20				Is the dry lot area regularly maintained to prevent manure buildup and areas of stagnant water? [DQ95]	
21				Do you keep your alley ways clean (scraped or flushed at least one time daily)? [DQ96]	
22				Do you keep your stalls clean (scraped at least one time daily)? [DQ97]	
23				Do you separate sick cows (potentially contagious) from healthy cows ASAP? [DQ102]	
24				Do you have an area used only for quarantine for newly introduced animals? [DQ104]	
25				Are cows kept on their feet for at least 30-45 minutes after milking to allow keratin plug formation in the teat canal? [DQ132]	
26				Is your somatic cell count routinely under 200,000? [DQ134]	
27				Do you use a CMT paddle on individual cows to monitor for mastitis? [DQ136]	
28				Do you limit your calving pens to calving only and not for isolation animals? [DQ151]	
29				Do you remove calves from mothers at birth, not allowing them to nurse? [DQ155]	
30				Do you collect colostrum within the first 2 hours after calving? [DQ161]	

Question #	Yes	No	Maybe		Comments
31				Do you immediately freeze your colostrum if it will be stored for more than 24 hours in a labeled, sealed, single use container? [DQ164]	
32				Do you only use single source colostrum, not pooled from multiple cows? [DQ166]	
33				Do you give newborns 3/4 to 1 gallon of colostrum within the first six hours of life? [DQ168]	
34				Do you give a second dose (1/2 to 3/4 gallon) of colostrum 12 hours later? [DQ169]	
35				Do you pasteurize waste milk before feeding to calves? [DQ171]	
36				Do you utilize individual calf housing for newborn calves and ensure there is no direct contact between them? [DQ175]	
37				Do you clean water troughs/cups frequently (at least weekly)? [DQ184]	
38				Do you examine all feedstuffs closely for manure, mold, foreign material, and overall quality? [DQ190]	
39				Are your pen entrances designed to prevent people from stepping into the feed bunk? [DQ198]	
40				Do you avoid feeding leftover/uneaten feed from lactating animals to young stock? [DQ199]	
41				Do you investigate animals that will not eat or do not consume all of their feed? [DQ200]	
42				Do you use different equipment for feed and manure handling? [DQ201]	
43				If you use the same equipment for manure and feed, do you clean all manure off the bucket and tires and disinfect before using for feed? [DQ203]	
44				Do you prevent young animals from coming in contact with manure from older animals? [DQ204]	
45				Is the origin of all replacement heifers known? [DQ205]	